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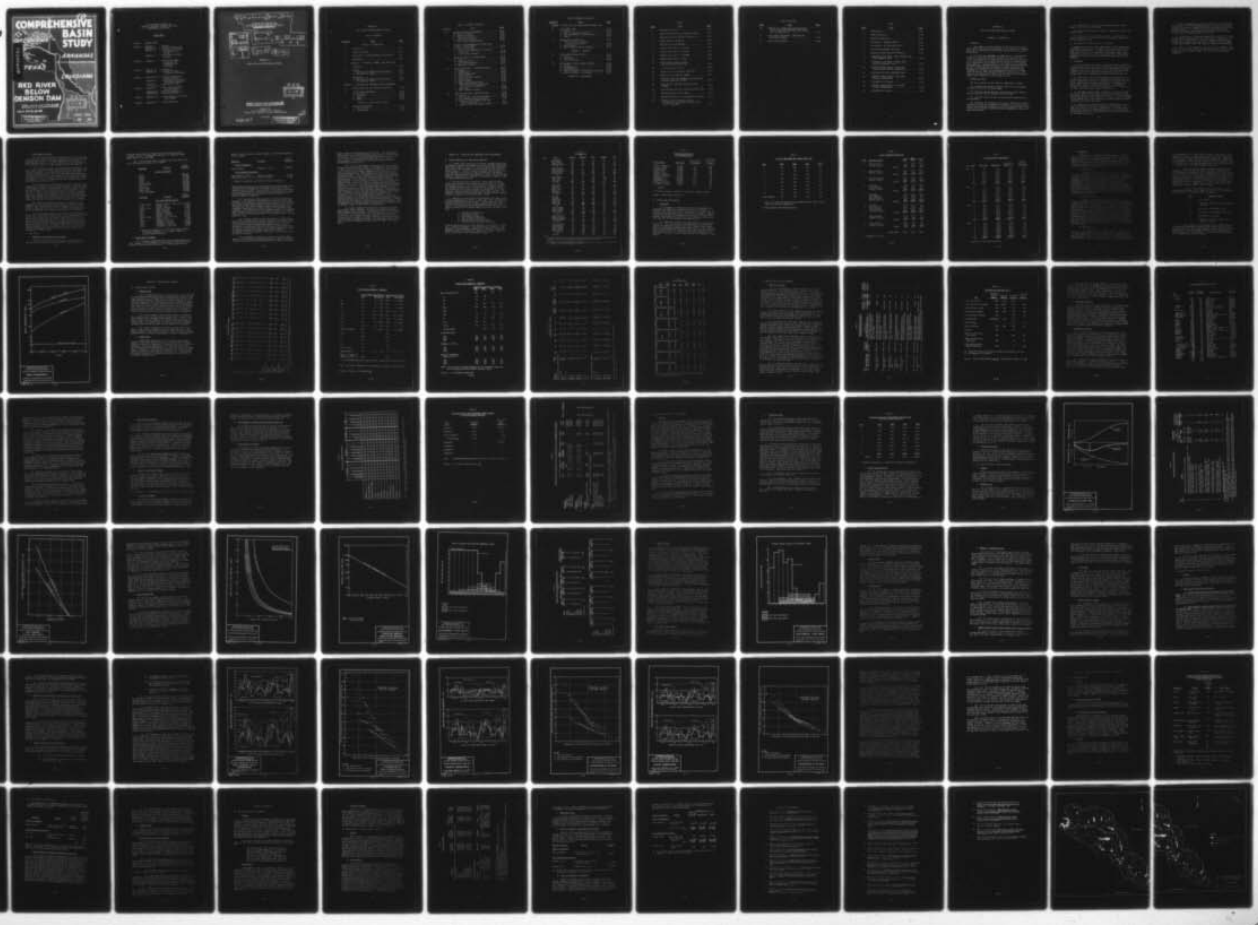
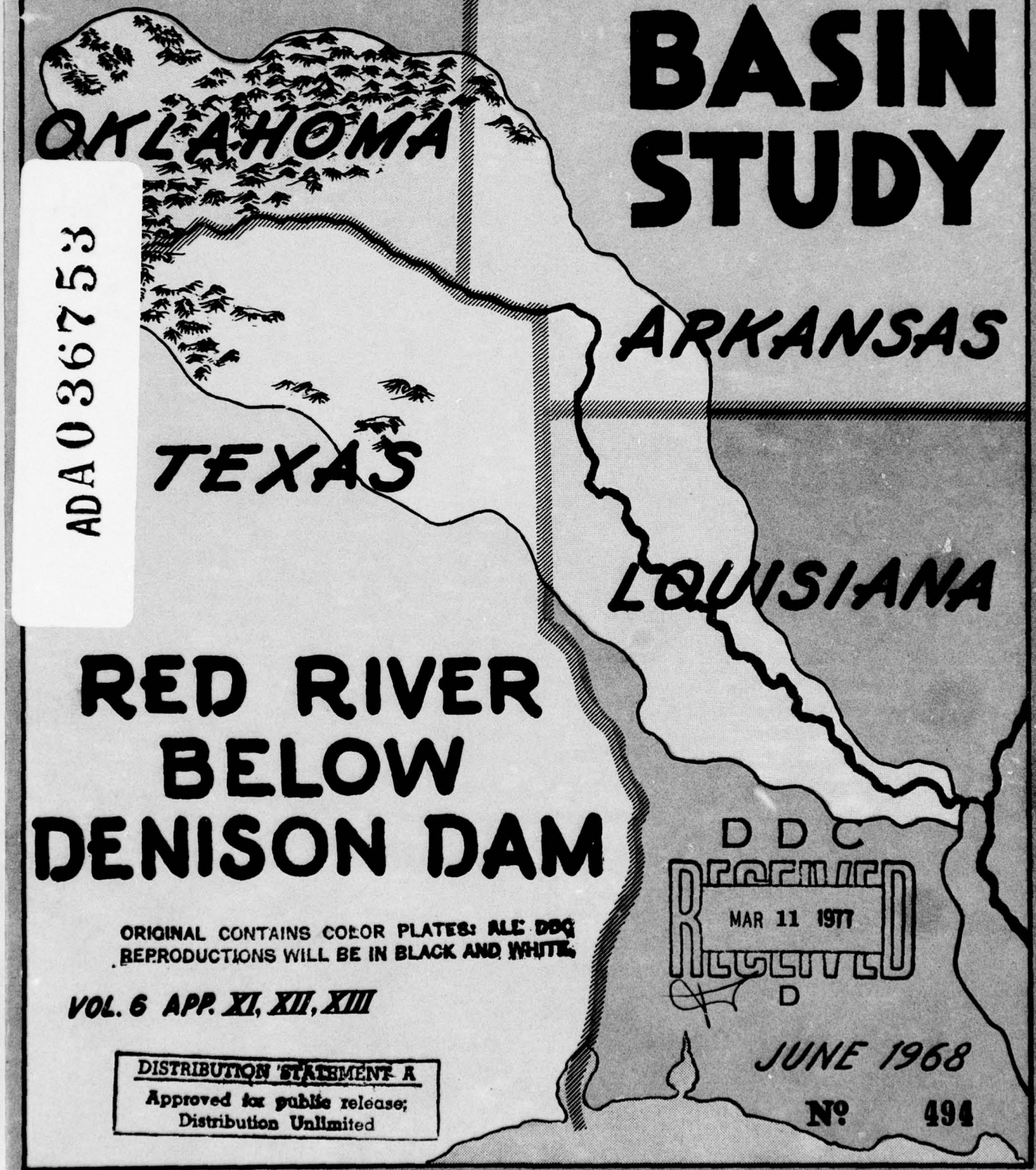


COMPREHENSIVE BASIN STUDY



RED RIVER BELOW DENISON DAM

ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

VOL. 6 APP. XI, XII, XIII

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RED RIVER BELOW DENISON DAM
ARKANSAS, LOUISIANA, OKLAHOMA, AND TEXAS
COMPREHENSIVE BASIN STUDY

VOLUME INDEX

(6) Comprehensive Basin Study.

RED RIVER BELOW DENISON DAM
ARKANSAS, LOUISIANA, OKLAHOMA, AND TEXAS.
~~COMPREHENSIVE BASIN STUDY~~

Volume 6.
Appendix XI, XII, and XIII.

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(12) 195 p.

APPENDIX XI

WATER SUPPLY AND WATER QUALITY CONTROL

ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

Prepared by
U. S. Department of the Interior
Federal Water Pollution Control Administration

June 1968

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WATER SUPPLY AND WATER QUALITY CONTROL

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APPENDIX XI

WATER SUPPLY AND WATER QUALITY CONTROL

CHAPTER I - INTRODUCTION

1. AUTHORITIES

a. This appendix has been prepared by the Federal Water Pollution Control Administration, Department of the Interior, as Chairman Agency of the Work Group on Water Supply and Water Quality Control Requirements.

b. By letter dated November 16, 1962, the U. S. Army Engineer District, New Orleans, Louisiana, requested the Public Health Service to provide data on needs and values for municipal and industrial water supply and for water quality control in the Red River basin below Denison Dam, exclusive of the Black River and Ouachita River subbasins. Responsibility for the study was transferred from the Public Health Service, Department of Health, Education, and Welfare, to the Federal Water Pollution Control Administration, Department of the Interior, by Reorganization Plan No. 2 of 1966, effective May 10, 1966. The water quality control portion of the study was considered under authority of the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et seq.).

2. PURPOSE AND SCOPE

The basic purposes of this study are summarized as follows:

(1) Determine the extent of present water use and development of resource facilities for water supply.

(2) Develop projected municipal and industrial water requirements in the basin for the 100-year period of study.

(3) Determine extent and type of existing and potential pollution problems.

(4) Determine, on the basis of the States' adopted Water Quality Standards, the need for supplemental streamflow or alternative pollution control measures to protect existing and projected uses of the streams, to protect the streams from further degradation, and to enhance water quality.

(5) Determine the effects of the comprehensive plan on the water quality of the basin streams.

(6) Evaluate alternatives to serve as a measure of benefits for proposed plans.

(7) Make a water supply allocation study to determine the origin and disposition of water necessary to meet the future municipal and industrial needs.

3. RELATIONSHIP TO OTHER PORTIONS OF THE REPORT

Population and other economic projections on which future water requirements are based were developed in connection with the Economic Base Study (Appendix I). Other selected data used in this report were extracted from appendixes on Hydrology, Surface and Ground Water and Geology; Irrigation; Hydroelectric Power; Mineral Resources and Mineral Industry; Outdoor Recreation; and Fish and Wildlife.

4. BACKGROUND

a. The Lower Red River basin, as shown on plate XI-1 (adjacent to back cover), lies in the States of Oklahoma, Texas, Arkansas, and Louisiana, and extends from Denison Dam at Texoma Reservoir southeastward to the Mississippi River. For the first 241 miles below Denison Dam, the river forms the border between the States of Oklahoma and Texas, and between the States of Arkansas and Texas.

b. The drainage area of the Red River below Denison Dam is 29,500 square miles, exclusive of the Ouachita and Black River subbasins. Major tributary basins included in the study are the Blue River, Boggy Creek, and Kiamichi River basins of Oklahoma; the Little River system of southeastern Oklahoma and southwestern Arkansas; the Sulphur River and Cypress Creek basins of Texas; and the Loggy and Saline Bayou systems of Louisiana.

c. The Lower Red River flows a distance of 675 miles through an alluvial valley of the Coastal Plains and discharges into the Atchafalaya and Mississippi Rivers via Old River. A large backwater area of approximately 2,650 square miles occurs in the flat lowlands in the general area of the confluence of the Red-Ouachita and Red-Atchafalaya and Mississippi Rivers.

d. The climate in the major portion of the Red River basin is warm and humid with precipitation ranging from 39 inches in the west to 57 inches in the east. Average flows in the main stem of the Red River vary from 3,800,000 acre-feet per year (5,058 cfs) below Texoma Reservoir to 23,450,000 acre-feet per year (32,390 cfs) at Alexandria, Louisiana.

e. There are approximately 19 major reservoirs in the Lower Red River basin, of which 9 are Federal projects constructed for flood control, water supply, hydroelectric power, recreation, and fish and wildlife purposes. The largest of the reservoirs are Millwood Reservoir in Arkansas and Oklahoma, and the Ferrells Bridge (Lake O' The Pines) and Texarkana Reservoirs in Texas.

f. The total basin (study area) population is about 1.7 million, and the average population density is about 58 per square mile. The largest cities are Shreveport (164,000), Alexandria (40,000) and Bossier City (33,000), Louisiana; Paris (21,000), Sherman (25,000), and Denison (23,000), Texas; and Texarkana (50,000), Texas-Arkansas.

g. Many and varied industries contribute to the economy of the basin. Of major significance are the primary metals (iron and steel), petroleum, pulp and paper, lumber, and food and kindred products industries.

CHAPTER II - DISCUSSION, SUMMARY, AND CONCLUSIONS

5. DISCUSSION

a. As a part of the Comprehensive Basin Study of the Red River below Denison Dam, investigations and studies have been made of the existing and potential needs for municipal and industrial water supply, the existing quality of water, the extent of existing and potential pollution, and the need for and benefits from conservation storage for municipal and industrial water supply and water quality control.

b. Municipal and industrial water supply needs were initially projected for the 50-year period, 1980 to 2030, and extrapolated through the period of study to the year 2080. They were based on population and other economic projections and on water-use data presented in the various appendixes to this report.

c. Supplemental streamflow needs for water quality control were also projected for the period of study. The estimated supplemental flow requirements were based on projected waste discharges to streams from cities and industries in the basin expected to have extensive expansion and development in the future. Criteria for determining the streamflow requirements to maintain acceptable water quality were based on the water quality standards adopted by the affected States of Louisiana, Arkansas, Oklahoma, and Texas. The parameters used as a measure of existing and potential water quality included dissolved oxygen, biochemical oxygen demand, total dissolved solids, chlorides, sulfates, nutrients, color, temperature, turbidity, and other selected criteria for the protection of future uses of the streams - uses that have been designated by the States.

d. The water quality standards adopted by the States provide for a minimum treatment level of "secondary" for municipal wastes and its equivalent for industrial wastes. Current technology has proven that a highly modern and efficient secondary treatment plant with highly skilled operators can achieve treatment levels in excess of 90 percent removal of biochemical oxygen demand (BOD) (5-day, 20° C.). However, comparison of operation data basinwide would reflect a lower efficiency due to many factors. A listing of these factors would indicate overloaded or obsolete facilities in some areas, malfunctions of equipment, accidental introduction of toxic materials, and a general shortage of adequately trained and efficient operators. For these reasons, an average treatment level of 90 percent has been used as a basis for computation of projected supplemental flow needs. However, it is recognized that advancement

in technology and training methods could greatly alter projected water quality control methods and needs in the future. Quality control needs should be periodically re-examined in view of changed economic conditions, quality objectives, use of the streams, treatment practices and treatment technology. Significant changes could alter or eliminate projected needs for supplemental flow for water quality control.

e. Streamflow deficiencies may exist in many areas of the basin, indicative of streams having inadequate base flows to properly assimilate projected waste discharges, adequately treated under the above criteria. These deficiencies have been shown in the report as net water quality control needs in reaches of the affected streams.

f. To meet a portion of the projected water quality control needs, storage has been provided in selected Federal reservoir projects. Benefits have been assigned to these projects based on portection of the State's assigned use of the streams. When these flows have fulfilled their objective they would become a resource to the stream and available for reuse for other beneficial purposes.

6. SUMMARY

a. Municipal and Industrial Water Supply:

(1) In 1965, municipal and industrial water use in the basin was approximately 220 million gallons per day (mgd). The average per capita water use by major cities in the basin was 115 gallons per capita per day (gpcd).

(2) Existing reservoirs and facilities have been developed in the basin to supply approximately 400 mgd for municipal and industrial purposes from reservoirs, rivers, and ground water aquifers. However, there are areas which have insufficient water supplies to meet projected demands of even the immediate future because of inadequate surface water or ground water resources.

(3) Municipal and industrial water requirements are expected to increase to about 600 mgd by 1980 and 1,300 mgd by 2030.

(4) Based on net basin water requirements, storage in Federal reservoirs and facilities will be needed to develop an additional total dependable yield of about 200 mgd by 1980 and 600 mgd by 2030.

(5) Prior to 1980, storage for municipal and industrial water supply purposes in the basin will be needed in 25 additional Federal reservoirs, 8 proposed for construction by the Corps of Engineers, and 7 by the Soil Conservation Service (exclusive of 2 alternative reservoir projects in the Blue River basin).

b. Water Quality Control:

(1) The chemical quality of surface waters of the main stem of the Red River below Denison Dam is generally poor because of high concentrations of dissolved solids, chlorides, and sulfates, and high carbonate hardness. Waters of the main stem are generally turbid, reflecting the river's high sediment load of sand and silt.

(2) The most extensive and serious pollution problem in the basin results from natural brine emissions and brine discharges from oil field operations in the Upper Red River basin (above Lake Texoma). At present, the water of the main stem below Denison Dam are generally unsuitable for municipal, industrial, and agricultural use without extensive treatment. However, some improvement in chemical quality is realized in downstream reaches through dilution by flows from large tributary rivers.

(3) The waters of major tributary streams, in general, are of good quality and their chemical constituents are within the Public Health Service Drinking Water Standards. However, inadequate treatment and handling of waste flows by cities and industries in some areas have caused serious pollution problems on certain tributary streams, as indicated by fish kills, high chloride concentrations, high color, foaming, rapid temperature variations, and oxygen depletion. Over one-half the wastes discharged in the basin (by total volume) are emptied into streams without adequate prior treatment.

(4) Pollution problems of the basin, in general, are a detriment to existing and potential municipal, industrial, rural domestic, and livestock water supply; to propagation of fish and wildlife; and to recreation use of the streams. The problems also result in degradation of aesthetics and the general environment.

(5) To meet water quality objectives for the protection of future uses of the streams of the basin, highly advanced waste treatment or disposal measures, provision of supplemental flow, or a combination of these measures will be needed at specific locations on at least 13 streams by 1980. This number would increase to at least 17 by the year 2030. Based on an assumed basinwide average of 90 percent removal of BOD from organic waste effluents from cities and an equivalent treatment of industrial wastes, streamflow deficiencies for adequate assimilation of the projected wastes will approximate 237 mgd by 1980.

7. CONCLUSIONS

a. Municipal and Industrial Water Supply:

(1) With construction of the proposed reservoir projects, and with proper utilization of ground water, return flows and

pollution control measures, sufficient water resources will be available to meet all foreseeable municipal and industrial water supply needs to the year 2080.

(2) Minimum annual value of benefits for water supply storage in the proposed projects are as follows:

Reservoir	Vicinity	Annual Benefits
	Corps of Engineers	
Albany		$262,000
Parker		245,000
Bonham		378,700
Durant		275,400
Liberty Hill		361,200
Bayou Dorcheat		499,000
Kisatchie		332,000
Titus County		871,000
McGee Creek		358,000
Caddo Enlargement		275,000

Watershed	Vicinity	Annual Benefits
	Soil Conservation Service	
3-19 (5 Res.)	Sherman, Bells, & Howe, Tex.	$ 67,920
3-25a	Bonham, Texas	19,400
*3-23 (2 Res.)	Durant, Oklahoma	57,480
3h2-4	Atoka, Oklahoma	6,750
3h2-6	Allen, Oklahoma	6,780
3i-4	Antlers, Oklahoma	33,340
3m1-7	Magnolia, Arkansas	101,600
3m2-3 (2 Res.)	Bossier City, Louisiana	35,200
3k-11	Deport, Texas	5,000
3o1-3	Ringgold, Louisiana	9,140
3o1-4	Gibsland, Louisiana	10,060
3-68	Alexandria, Louisiana	62,030
10-17	Alexandria, Louisiana	38,700

(* Alternative project to initial water supply storage for Durant, Oklahoma, in the Corps of Engineers proposed Durant Reservoir)

b. Water Quality Control:

(1) To provide streamflow regulation for water quality control, storage has been provided in three proposed Federal reservoir projects in the Lower Red River basin. Minimum annual value of

benefits for water quality control storage in the proposed projects are as follows:

Reservoir	Vicinity	Annual Benefits*
Corps of Engineers		
Bayou Dorcheat	Magnolia, Arkansas	$509,000
Soil Conservation Service		
Big Creek (Ws. 3 ml-7)	Magnolia, Arkansas	26,200
Little Blue River (Ws.3-23)	Durant, Oklahoma	10,000

* Based on Alternative Cost Method of benefit evaluation.

These projects together with existing reservoirs, would supply about 70 percent of the supplemental flow needs in tributary areas projected for the year 1980. Minimum annual benefits that would accrue to the proposed projects by protection of fish and wildlife, recreation and other beneficial uses would be $283,700 (based on Use Method of benefit evaluation).

(2) In remaining tributary areas of the basin where major problems are anticipated, other methods of pollution control would be needed in the absence of yield from water quality control storage. These would include higher degrees of waste treatment, and releases from municipal and industrial water supply storage (Sulphur River, contractural agreements) as needed to maintain established stream standards. With construction of the proposed reservoirs and adequate waste treatment facilities and other control measures, the surface waters of the tributary basins would be of acceptable quality for all beneficial uses.

(3) Extensive studies of the salt problem in the Red River by the Public Health Service, Corps of Engineers, and Federal Water Pollution Control Administration have shown that the natural chloride pollution could be substantially reduced through control measures at nine principal brine emission areas in the upper basin, in addition to the existing project at Estelline Springs. The various measures proposed in previous studies would reduce salt discharges to the river from 40 to 50 percent. Top priority should be given this project.

(4) Improvement to quality of the main stem below Index, Arkansas, would result from proposed diversion of about 550 mgd during the critical period from the Red River above Index to the water

supply system of the proposed Texas Water Plan. This improvement would result during low-flow periods from diversion of water having a higher salt content than major inflows from the Little River system. Diversions during high flows would have little effect on stream quality in the Red River, but diversion during low-flow periods would be beneficial.

(5) Full basin development, exclusive of the salt control measures, will have a major effect on improvement of water quality in the Red River below Fulton, Arkansas. Additional benefits would accrue to the projects through augmentation of low-flows in the lower Mississippi River. With completion of Broken Bow Reservoir and other elements of the authorized Little River system, proposed hydroelectric peaking power releases would alleviate potential pollution problems on the tributary streams and reduce chloride concentrations in the main stem of the Red River in the Fulton area. Some reduction in beneficial effect of these flows would result, however, in the reach of the Red River between Fulton and Shreveport, Louisiana, as a result of oil field and projected paper mill operations in this area, and reduced inflows from tributary streams. Irrigation return flow is not expected to present a significant problem. During the critical period, June 1953 through February 1957, the mean monthly weighted average chloride concentration at Shreveport, Louisiana, was approximately 150 mg/1. Without salt control measures in the Upper Red River basin above Denison Dam, the chloride concentration of the river at Shreveport would be at approximately this level during a recurrence of the critical drought. With the proposed salt control measures, concentration of chlorides would be reduced to about 70 mg/1 during the same period.

(6) Quality problems projected for the reach of the main stem between Fulton, Arkansas, and Shreveport could be minimized with adequate control measures. Projected quality of the Red River would be better than reflected in the analysis more than 95 percent of the time. The analysis was made on the basis of recurrence of the most critical drought on record. However, selective withdrawal and off-channel storage are the keys to a continuous supply of good water to cities and industries whose source of supply is the Red River.

CHAPTER III - MUNICIPAL AND INDUSTRIAL WATER REQUIREMENTS

8. PRESENT MUNICIPAL AND INDUSTRIAL WATER USE

a. In 1965, urban water use in the basin averaged about 84 mgd for domestic, service and commercial business, and small industrial water supply purposes. 1-5/ This quantity represented approximately 30 percent of the total water use in the basin for that year, as shown in table 1. To date, existing reservoirs and facilities have been developed in the basin to supply approximately 400 mgd for urban and industrial needs from reservoirs, rivers, and ground water aquifers. Approximately 65 percent of the municipal supply in 1963 was obtained from ground water.

b. The municipalities of the basin having organized public water supply systems had an average per capita water use of about 115 gallons per day in 1965. This average was slightly less than the 124 gpcd average use of the major cities, as shown in table 2. The varying per capita water use reflects concentrations of small industries normally supplied by public water supply systems. The quantity of municipal water used by small industry averages approximately 20 percent to the total municipal use. 6/

c. Industries of the basin used approximately 137 mgd of water in their manufacturing processes in 1965. 1-4/ About 12 percent was obtained from municipal water systems. The remainder was supplied from other public and private surface supplies and ground water sources. The heavy water using industries presently located in the basin can generally be classified under one of the following categories:

1. Thermal power generation
2. Petroleum refining
3. Petrochemical production
4. Pulp and paper manufacture
5. Primary metals (iron and steel)
6. Food and kindred products production

Location and description of these industries are presented in Appendix I, Economics; Appendix V, Upstream Watershed Protection, Use, Management, and Development; Appendix VIII, Mineral Resources and Mineral Industry; and Appendix X, Hydroelectric Power. Industrial water use in 1965 by area is presented in table 1.

Table 1

1965 Basin Water Use
(mgd)

Area	County	Municipal	Industrial*	Rural	Irrigation	Total
1	Atoka, Oklahoma	0.5	--	0.4	0.7	1.6
	Choctaw, Oklahoma	0.6	0.2	0.5	0.8	2.1
	Coal, Oklahoma	0.2	--	0.3	--	0.5
	Pontotoc, Oklahoma	0.1	0.9	0.4	0.3	1.7
	Pushmataha, Oklahoma	0.2	--	0.5	0.7	1.4
	Total	1.6	1.1	2.1	2.5	7.3
2	Hempstead, Arkansas	0.8		0.7	0.2	1.7
	Howard, Arkansas	0.5	0.3	0.6	0.1	1.5
	Little River, Arkansas	0.2	0.3	0.6	0.7	1.8
	Sevier, Arkansas	0.9	--	0.6	--	1.5
	McCurtain, Oklahoma	0.7	4.4	1.0	2.7	8.8
	Total	3.1	5.0	3.5	3.7	15.3
3	Bryan, Oklahoma	2.3	0.5	0.6	2.8	6.2
	Johnston, Oklahoma	--	--	0.2	0.6	0.8
	Fannin, Texas	1.3	--	0.8	--**	2.1
	Grayson, Texas	6.7	--	0.5	--**	7.2
	Lamar, Texas	3.0	0.2	0.7	0.1	4.0
	Total	13.3	0.7	2.8	3.5	20.3
4	Miller, Arkansas	5.5	0.2	1.0	1.8	8.5
	Bowie, Texas	6.2	11.9	1.2	3.5	22.8
	Delta, Texas	0.1	--	0.3	--	0.4
	Franklin, Texas	0.2	0.9	0.2	--	1.3
	Hopkins, Texas	0.9	0.2	0.3	0.1	1.5
	Hunt, Texas	0.7	--	0.2	--	0.9
	Red River, Texas	0.4	--	0.6	0.3	1.3
	Titus, Texas	1.3	0.9	0.4	--	2.6
	Total	15.3	14.1	4.2	5.7	39.3
5	Camp, Texas	0.3	--	0.2	0.1	0.6
	Cass, Texas	0.8	0.4	1.0	0.1	2.3
	Gregg, Texas	--	--	0.1	--	0.1
	Harrison, Texas	4.0	3.6	0.7	0.1	8.4
	Marion, Texas	0.4	--	0.3	0.1	0.8
	Morris, Texas	1.2	34.5	0.5	0.1	36.3
	Upshur, Texas	0.7	0.4	0.5	--	1.6
	Total	7.4	38.9	3.3	0.5	50.1
6	Columbia, Arkansas	1.3	1.2	0.6	0.1	3.2
	Lafayette, Arkansas	0.4	0.8	0.5	4.1	5.8
	Bossier, Louisiana	3.6	1.1	1.2	2.0	7.9
	Caddo, Louisiana	20.7	7.9	1.9	5.1	35.6
	Webster, Louisiana	2.3	42.3	0.8	--	45.4
	Total	28.3	53.3	5.0	11.3	97.9
7	Bienville, Louisiana	0.3	0.9	0.6	--	1.8
	DeSoto, Louisiana	0.7	0.2	0.6	--	1.5
	Natchitoches, Louisiana	1.2	--	1.1	0.1	2.4
	Red River, Louisiana	0.2	--	0.6	--	0.8
	Sabine, Louisiana	--	0.3	0.1	--	0.4
	Total	2.4	1.4	3.0	0.1	6.9
8	Avoyelles, Louisiana	1.2	0.4	0.4	1.5	3.5
	Grant, Louisiana	0.1	0.2	0.5	0.3	1.1
	Jackson, Louisiana	0.6	13.0	0.3	--	13.9
	LaSalle, Louisiana	0.5	0.4	0.3	--	1.2
	Rapides, Louisiana	7.3	5.8	0.9	0.8	14.8
	Winn, Louisiana	1.8	0.2	0.4	--	2.4
	Lincoln, Louisiana	1.4	2.3	0.1	--	3.8
	Total	12.9	22.3	2.9	2.6	40.7
	BASIN TOTAL	84.3	136.8	26.8	29.9	277.8

Source:

Geological Survey[1], Louisiana Geological Survey and Louisiana Department of Public Works[2], Oklahoma Water Resources Board[3], Geological Survey and Arkansas Geological Commission[4], and Public Health Service[5].

* For thermal electric power, only consumptive use is reflected.

** No irrigation in 1965. In 1964 irrigation use for Fannin and Grayson Counties was 1.5 and 0.1 m.g.d., respectively. [Source: Texas Water Commission Inventory (Bul. 6515)]

Table 2

Present Unit Water Use
of Principal Cities

City & State	Population	Average Water Use (mgd)	Gallons per Capita per Day*
Durant, Oklahoma	14,000	2.3	164
Denison, Texas	25,000	3.5	140
Sherman, Texas	31,000	3.0	97
Paris, Texas	23,500	3.0	128
Marshall, Texas	24,255	3.9	159
Magnolia, Arkansas	12,000	0.9	75
Bossier City, La.	35,500	3.3	93
Shreveport, La.	174,000	20.7	119
Alexandria, La.	60,000	5.5	92
Ruston, Louisiana	14,050	1.3	93
Texarkana, Tex-Ark.	62,100	11.5	185
Average	-	-	124

* Include industries supplied by public water supply systems.

Source: Public Health Service 5/

9. FUTURE WATER REQUIREMENTS

a. Municipal

(1) Estimates of future municipal water requirements were developed from population projections contained in Appendix I, Economics, and from studies of per capita water use in the Lower Red River basin and contiguous areas. The studies included an analysis of water use records from municipalities, analysis of basin characteristics pertaining to precipitation and climate, and comparison of data with that of other agencies and municipalities.

(2) Projected values of per capita municipal use are shown in table 3. These values reflect only projected use for domestic, service and commercial business, and small industrial water supply needs to be supplied by public water supply systems. Water requirements for heavy water-using industries have been projected separately and presented in table 4. Total projected water requirements are presented in table 5, for areas shown on plate XI-1 (adjacent to back cover).

Table 3

Projected Municipal per Capita Water Use*

Area	1980	2000	2030	2080**
1	115	140	165	165
2	110	125	155	155
3	140	150	170	170
4	135	145	160	160
5	130	140	155	155
6	125	135	145	150
7	105	120	135	135
8	105	115	130	130
Basin Average	125	135	150	150

* Does not include heavy water-using industries whose water requirements are projected separately.

** Extrapolated from 2030 projections.

Table 4

Future Industrial Water Use

Area	Type of Industry		mgd 1980	2000	2030
1	Pulp and Paper		0	25.0	49.0
	Thermal Electric*		2.0	2.7	3.7
		Totals	2.0	27.7	52.7
2	Pulp and Paper		75.0	92.1	119.0
	Thermal Electric*		1.6	1.9	2.3
		Totals	76.6	94.0	121.3
3	Food and Kindred		13.0	14.9	19.0
	Thermal Electric*		7.0	9.0	12.1
		Totals	20.0	23.9	31.1
4	Petroleum		8.0	17.0	27.0
	Pulp and Paper		60.0	70.0	70.0
	Thermal Electric*		8.0	10.5	14.0
		Totals	76.0	97.5	111.0
5	Petroleum		5.0	10.0	17.0
	Petro-Chemical		34.0	68.0	86.1
	Iron and Steel		14.0	22.0	33.0
	Thermal Electric*		8.0	10.0	12.9
		Totals	61.0	110.0	149.0
6	Petroleum		11.0	22.0	35.0
	Pulp and Paper		46.3	46.3	46.3
	Petro-Chemical		52.0	103.0	165.0
	Thermal Electric*		22.3	32.0	44.9
		Totals	131.6	203.3	291.2
7	Pulp and Paper		25.0	25.0	27.7
	Thermal Electric*		3.0	4.4	6.3
		Totals	28.0	29.4	34.0
8	Pulp and Paper		70.3	70.3	70.3
	Thermal Electric*		9.5	13.9	19.4
		Totals	79.8	84.2	89.7
		Basin Totals	475.0	670.0	880.0

* Consumptive use only.

Table 5

Projected Water Requirements

Year	Area	Municipal	Industrial	Municipal & Industrial	Rural Domestic & Livestock
1980	1	4.6	2.0	6.6	4.0
	2	3.5	76.6	80.1	4.9
	3	18.6	20.0	38.6	7.1
	4	21.0	76.0	97.0	8.3
	5	18.5	61.0	79.5	8.0
	6	50.6	131.6	182.2	10.0
	7	5.8	28.0	33.8	7.4
	8	18.2	79.8	98.0	13.4
	Total	140.8	475.0	615.8	63.1
2000	1	8.1	27.7	35.8	4.0
	2	4.9	94.0	98.9	5.1
	3	29.0	23.9	52.9	6.9
	4	32.5	97.5	130.0	8.4
	5	27.9	110.0	137.9	7.8
	6	84.5	203.3	287.8	10.1
	7	10.8	29.4	40.2	7.5
	8	31.3	84.2	115.5	14.1
	Total	229.0	670.0	899.0	63.9
2030	1	14.1	52.7	66.8	3.8
	2	8.2	121.3	129.5	4.9
	3	46.7	31.1	77.8	6.8
	4	50.9	111.0	161.9	8.3
	5	43.6	149.0	192.6	7.3
	6	146.3	291.2	437.5	9.8
	7	19.5	34.0	53.5	7.3
	8	56.6	89.7	146.3	14.6
	Total	385.9	880.0	1,265.9	62.8
2080*	1	25.1	98.0	123.1	3.8
	2	11.2	122.0	133.2	4.9
	3	93.4	52.0	145.4	6.8
	4	102.2	145.0	247.2	8.3
	5	79.8	210.0	289.8	7.3
	6	358.9	415.0	773.9	9.8
	7	40.8	49.0	89.8	7.3
	8	133.0	109.0	242.0	14.6
	Total	844.4	1,200.0	2,044.4	62.8

* Extrapolated from 2030 projections.

b. Industrial

In determining industrial water requirements, industries were selected for study that have water needs in excess of those usually supplied by municipal water supply systems. In the Lower Red River basin, the significant heavy water-using industries are petrochemical, food and kindred processing, pulp and paper manufacturing, primary metals (iron and steel), petroleum refining, and thermal electric power generation. 7/

(1) Petrochemical

Petrochemical manufacturing is the second largest industrial water use group in the basin. This industry is expected to expand principally in areas 5 and 6 near the cities of Magnolia, Arkansas; Shreveport, Louisiana; and Marshall, Texas. Water requirements for the industry have been based on an estimated production of 2.6 million tons annually in area 5 and 5 million tons annually in area 6 by the year 2030. Average water demands at present for cooling and process water in the petrochemical industry are approximately 42 gallons per pound (84,000 gallons per ton). 8/ Future water demands have been estimated on the basis of 85 percent recirculation or an approximate unit water use of about 12,000 gallons per ton of production.

(2) Food and Kindred

Growth of the food and kindred processing industry is forecast throughout the basin, with heaviest concentrations expected to develop in area 3 near the cities of Sherman, Denison, and Paris, Texas. Future water requirements for the industry in other areas of the basin than area 3 are reflected in the projected urban per capita water use. Specific studies were made in prior reports 8,9/ for the food and kindred processing industry in area 3. In addition, extensive studies have been made by the Campbell Soup Company at Paris, Texas, by the cities in this area, and by the Texas Water Development Board. Results of the studies indicate that, in addition to municipal supplies, approximately 19 mgd will be needed for the food processing industry in this area by the year 2030, as reflected in table 4. Recirculation of process water is not projected for this industry.

(3) Pulp and Paper

(a) There are over 10 million acres of forest lands within the Lower Red River basin, as described in Appendixes I and V. These areas provide the raw materials for the largest single heavy water-using industry in the basin, the pulp and paper manufacturing industry. Projected water requirements for this industry are

over 40 percent of the total industrial needs of the basin. Data furnished by the U. S. Forest Service indicates that pulp and paper production by 1980 will approximate 5,900 tons per day. (Appendix V). Subsequent studies indicate that daily production output rates could logically increase to about 8,000 tons by the year 2030, based on a rapidly growing demand for paper products and improved manufacturing processes and forestry management practices.

(b) The pulp and paper manufacturing processes most prevalent in the basin are the sulphate (Kraft), bleached Kraft, and groundwood pulp processes. Water requirements for these industrial operations range from 35,000 to 68,000 gallons per ton of dry pulp. In general, mills using bleaching processes for production of high grade bond paper, bleached board, or offset paper require over 53,000 gallons per ton. Water requirements for those producing paper board and lower grade paper, in general, range from 35,000 to 48,000 gallons per ton. 8,10/ Because of the color problem, there would be very limited re-use of process water.

(c) Extensive expansion and new development of the pulp and paper industry in the Lower Red River basin is projected to occur in at least six general areas, as follows:

Area	General Vicinity
1	Hugo, Oklahoma
2	Broken Bow, Oklahoma; Hope and Ashdown, Arkansas
4	New Boston and Texarkana, Texas
6	Shreveport and Springhill, Louisiana
7	Natchitoches, Louisiana
8	Alexandria, Pineville, Ruston, and Hodge, Louisiana

(d) Because of the existing and anticipated diversity in manufacturing processes, product market demands, raw materials, and other variables, future water demands for the industry have been projected on a basinwide average unit water use of approximately 48,000 gallons per ton of production. Projected water requirements for the industry are shown in table 4.

(4) Primary Metals - Iron and Steel

Industrial development for iron and steel in the Lower Red River basin is centered in area 5. The Lone Star Steel Company plant at Lone Star, Texas is the primary iron and steel industry in this area. The future annual rate of growth for the east Texas steel industry is expected to approximate the projected national rate of 2 percent for steel ingot production and 1 percent for pig iron production, compounded yearly. 8/ The present annual production rate of 0.8 million tons should increase to about 2.6 million tons by the year 2030. Current water use is about 10.2 mgd or approximately 4,600 gallons per ton of production.

(5) Petroleum Refining

Continued expansion of the petroleum refining industry is projected for the eastern Texas and western Louisiana portions of the Lower Red River basin, in areas 4, 5, and 6 shown on plate XI-1. Production in these areas is expected to total about 213,000 barrels per day by the year 2030. Gross water requirements approximate 1,700 gallons per barrel 11/ for the refinery process. Since the major portion is required for cooling, projected water requirements have been based on 80 percent recirculation. Fresh water intake required for cooling "make-up" and other purposes is approximately 350 gallons per barrel of production.

(6) Power Generation

(a) An expansion in the number and size of steam-electric generation plants is projected to accompany other industrial growth in the Lower Red River basin. Large quantities of water are required for cooling compared to the consumptive use which has been projected in tables 4 and 5. The consumptive use of water for steam-electric generation is that portion of the total water requirements of the plant which is lost in the boiler feedwater make-up system and lost in the condenser cooling system. Consumptive use is approximately one percent of the amount of cooling water used and is expected to decrease slightly by 1980. For steam-electric plants that use cooling towers in lieu of recirculation through a reservoir, the consumptive use would be approximately two percent of the cooling water requirements. Nuclear thermal plants currently require about 50 percent more consumptive condenser water for a given temperature rise than fossil-fueled thermal-electric plants of equal size. It is expected that this added requirement will decrease to about 25 percent by 1980.

(b) In estimating the consumptive use of water for thermal power generation in the basin, the projected per capita energy requirement has been related to consumptive water use per unit

of energy produced. Energy requirements were projected on the basis of a per capita rate of 62.7 kilowatt-hours per day. 6/ Power needs expected to be met by hydroelectric installation in the basin were deducted from the total to estimate the requirements for supply by thermal-electric plants. Estimates of consumptive use of water for thermal power generation in the basin were based on a unit water use of 0.3 gallons per kilowatt-hour. 8/ Distribution throughout the basin has been based on projected population to be served by the thermal-electric plants. Projected distribution of population is shown in Appendix I.

(7) Summary

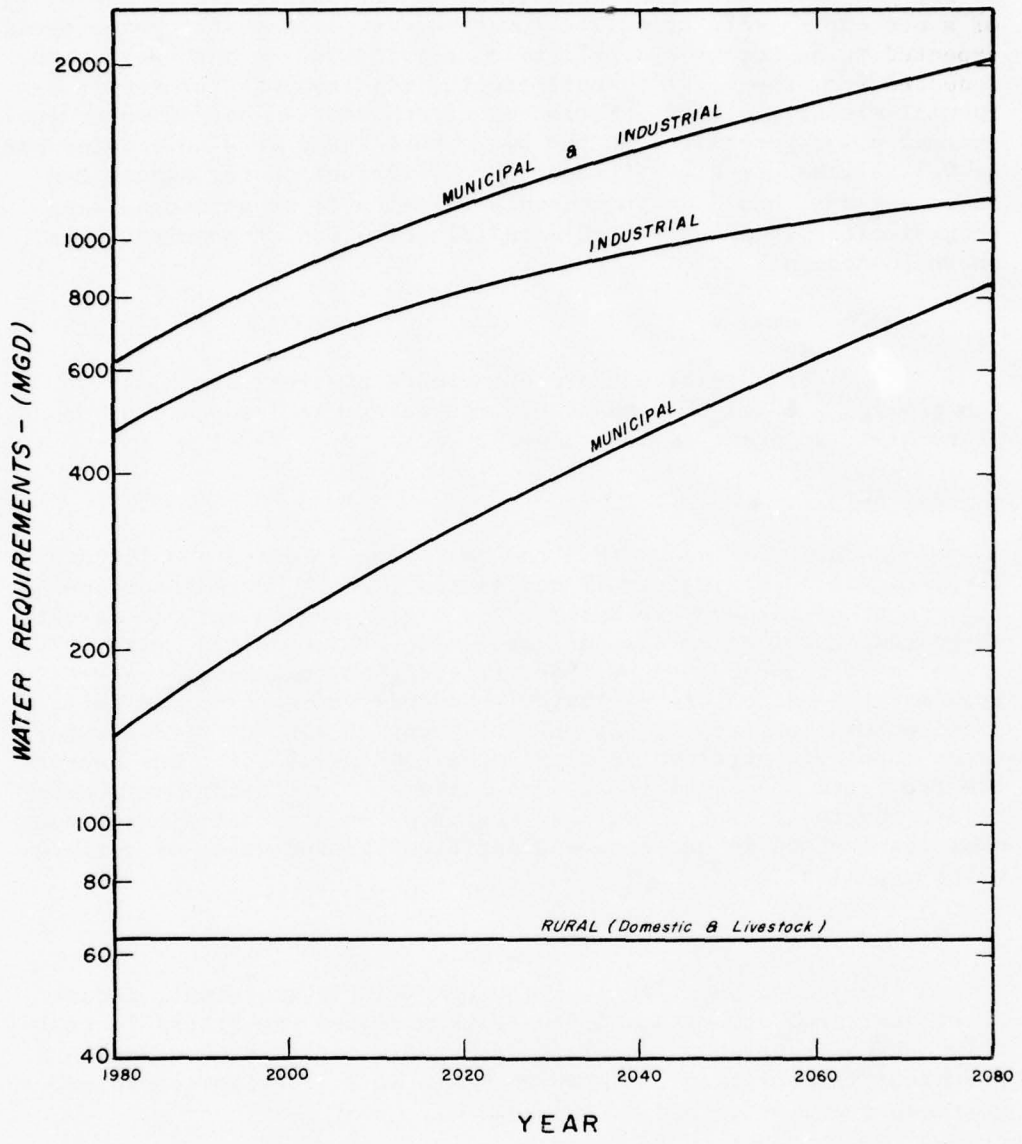
Industrial water requirements by areas are shown in table 4 for 1980, 2000, and 2030. The water use areas are shown on plate XI-1 (adjacent to back cover).

c. Rural

Rural water use within the basin for domestic and livestock purposes was approximately 27 mgd in 1965, which represented about 10 percent of the average daily water use in the basin. It is estimated that rural water demands, exclusive of irrigation, will increase to about 63 mgd by 1980. The higher demand will result from maintenance of higher living standards rather than any anticipated population growth. At present about 90 percent of the rural water supply is obtained from privately owned wells. Other sources are from farm ponds, cisterns, and streams. To provide for future needs, reservoir storage will be required for at least 5 rural communities located in areas having deficient ground water or surface water supplies.

d. Summary

Projected water supply requirements for municipal, industrial and rural domestic and livestock purposes are listed in table 5 for basin areas shown on plate XI-1 (adjacent to back cover). A graphical illustration is shown on plate XI-2. Irrigation water requirements are described in Appendix VI.



COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS

WATER REQUIREMENTS

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
JUNE 1968

PLATE XI-2

CHAPTER IV - WATER QUALITY CONTROL

10. PRESENT WATER QUALITY

a. Surface Water

(1) The chemical quality of surface waters of the main stem of the Red River below Denison Dam is generally poor because of the high concentration of dissolved solids, chlorides and sulfates, and high carbonate hardness. Quality of the stream, however, is considerably improved as the river flows eastward and southward toward the Mississippi River. Large tributary rivers having high quality water empty into the Red River and significantly dilute the flows of the main stem, thus causing a sizeable reduction in the concentration of dissolved solids. Waters of the main stem are generally turbid, reflecting the river's high sediment load of sand and silt.

(2) Surface waters of the tributary basins, in general, are of good quality and their chemical constituents are within the Public Health Service Drinking Water Standards. 12/ However, low flows in some tributary streams, particularly the upper reaches of Sulphur River, are somewhat high in calcium and magnesium hardness resulting from solution of chalk and marl deposits in the areas.

(3) Tables 6 through 9 show typical stream quality data on the main stem and major tributaries of the Lower Red River. The tables, however, do not reflect extremes or most critical conditions. Additional data on present stream quality is given in Appendix III.

b. Ground Water

Ground water from nearly all the principal fresh-water aquifers of the Lower Red River basin is of good quality, and generally is suitable for municipal or industrial use with little or no treatment. The chief characteristics of the water, particularly that from the Red River alluvium, are its high iron content and high degree of hardness. Water from the formations of Tertiary age generally is unsuitable for continuous irrigation use. Detailed data on quantity and quality of ground water available in the basin is contained in Appendix III.

Table 6

Surface Water Quality - Louisiana

	Red River at Hosston									Red River at Alexandria									
	1958	1959	1960	1961	1962	1963	1964	1965	1966	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
SiO_2	12	11	11	7.7	9.5	7.8	9.0	10.0	6.2	13	14	11	11	12	12	12	11	9.0	8.8
Fe	0.09	0.12	0.07	0.09	0.11	0.07	0.07	0.03	0.05	-	0.04	0.11	0.12	0.11	0.16	0.12	0.07	0.14	0.09
Ca	42	47	51	56	43	45	41	37	45	39	57	42	67	53	34	41	49	42	35
Mg	6.5	12	15	12	11	12	10	7.6	8.8	11	16	8.7	16	13	5.3	12	12	9.6	9.5
Na	-	69	78	83	66	63	55	40	57	-	-	-	-	-	-	62	73	66	50
Na & K	44	-	-	-	-	-	-	-	-	51	97	62	123	79	36	-	-	-	-
K	-	3.0	3.3	3.1	2.9	3.2	3.0	2.5	3.4	-	-	-	-	-	-	2.8	2.7	3.1	2.5
HCO_3	103	114	115	112	99	104	100	95	110	113	140	103	136	136	93	108	113	92	89
SO_4	47	71	92	88	71	71	59	46	60	46	86	54	117	67	32	54	75	60	48
Cl	64	111	123	130	101	102	86	62	88	79	151	95	188	121	53	102	115	110	81
F	0.4	0.4	0.4	0.4	0.2	0.2	0.2	0.2	0.2	-	-	-	-	-	0.4	0.3	0.4	0.3	0.1
NO_3	0.7	0.6	0.5	0.5	0.5	0.5	0.5	0.4	0.4	1.5	1.5	1.6	1.3	0.9	0.7	0.6	0.5	0.6	0.5
SAR	1.6	2.2	2.5	2.6	2.1	2.0	2.5	1.4	1.8	1.9	2.9	2.3	3.3	2.4	1.5	2.1	2.4	2.4	1.8
pH (pH units)	-	-	-	-	7.1	7.3	7.2	6.8	7.5	-	-	-	-	-	-	-	-	-	7.2
Color (color units)	-	62	30	33	42	28	33	21	24	-	-	-	-	-	-	55	30	50	43
Dissolved Solids																			
Maximum	706	965	932	1,160	1,170	942	1,190	1,020	961	798	846	809	1,070	1,130	532	922	871	1,080	899
Average	287	400	464	478	392	381	345	269	338	302	516	351	613	422	235	359	420	384	312
Minimum	129	121	171	164	130	153	117	117	120	91	164	149	174	144	110	175	175	169	137
Hardness, as $CaCO_3$																			
Maximum	282	356	364	395	374	362	395	390	334	365	360	332	408	464	206	364	332	352	339
Average	132	167	189	189	153	163	143	123	151	142	208	141	233	186	197	152	171	144	124
Minimum	74	68	89	68	70	73	66	62	75	57	76	66	77	65	70	74	85	71	72
Specific Conductance (μmhos at 25°C.)																			
Maximum	1,200	1,760	1,730	1,850	1,830	1,550	1,950	1,860	1,680	1,430	1,510	1,440	1,850	2,020	953	1,660	1,560	1,870	1,460
Average	467	663	757	786	618	636	546	449	580	523	872	582	1,030	726	382	596	691	628	503
Minimum	214	165	166	152	160	205	166	164	198	133	232	204	255	231	180	249	189	194	248
Mean Discharge, cfs	31,000	11,490	20,900	20,400	19,820	11,700	8,040	13,710	14,430	34,520	16,190	20,140	13,550	45,970	50,610	18,720	26,810	34,900	34,470

NOTE: All values are discharge weighted averages for the respective water year except for 1959, 1960 and 1961 which are time-weighted averages, and 1954 and 1955 which are arithmetic averages. All values are expressed in mg/l unless otherwise noted.

Source: U. S. Geological Survey[13/]

Table 7

Surface Water Quality - Arkansas

	Little River near Horatio		Red River at Fulton	
	Mean	Data Range*	Mean	Date Range*
Ca	6.7	0 - 14.0	46.9	0 - 102.4
Mg	1.8	0 - 8.8	11.1	0 - 26.1
Na	16.2	0 - 57.8	70.1	0 - 181.8
K	1.3	0.3 - 2.3	3.79	0.3 - 7.3
HCO_3	22.7	6.4 - 39.0	96.2	9.4 - 183.0
SO_4	4.1	0.3 - 7.9	79.0	0 - 203.2
Cl	26.1	0 - 100.0	109	0 - 286.8
NO_3	1.1	0 - 2.9	1.39	0 - 3.3
Dissolved Solids	92.7	0 - 236.2	417	0 - 979.3
SiO_2	5.9		6.6	
Fe	0.08		0.06	
F	0.2		0.3	
pH	6.9		7.6	
Color, Units	21		21	
Temperature, ^oC	18	13 - 21	17	14 - 22
Specific Conductance (μmhos/cm @ 25^o C)	139		417	

* Two standard deviations about the mean, taking in 95.4% of the cases.

NOTE: All values expressed as mg/l, except pH, unless otherwise noted.

Source: University of Arkansas 14/

Table 8

Surface Water Quality - Oklahoma

	Blue River near Blue, Oklahoma			
	1960	1961	1962	1963
Mean Discharge (cfs)	231	-	254	-
Ca	50	48	-	-
Mg	19	17	-	-
Na	5.3	8.0	7.8	7.5
HCO_3	228	206	183	175
CO_3	-	3	3	-
SO_4	15	15	14	14
Cl	7.3	7.3	6.6	6.7
NO_3	2.0	1.7	-	-
S.A.R.	0.2	0.3	0.3	0.3
pH (pH units)	-	8.1	7.9	7.9
Dissolved Solids				
Max.	317	317	334	369
Ave.	228	226	199	193
Min.	183	123	55	78
Hardness, as $CaCO_3$				
Max.	300	288	284	286
Ave.	203	183	162	159
Min.	160	92	40	58
Specific Conductance (mhos at 25° C)				
Max.	547	555	598	582
Ave.	387	365	324	319
Min.	194	164	92	130

NOTE: All values are weighted averages for the respective water year and are expressed in mg/l unless otherwise noted.

Source: U. S. Geological Survey 13/

Table 8 (Continued)

Surface Water Quality - Oklahoma

Date of Collection	Discharge cfs	SiO_3	Ca	Mg	HCO_3	CO_3	SO_4	Cl	Dissolved Solids	Hardness as $CaCO_3$	S.A.R.	Specific Cond. µmhos at 25° C	pH
MUDDY BOGGY CREEK near FARRIS, OKLAHOMA													
Oct. 11, 1962	3350	4.2	2.8	1.7	14	0	8.2	2.9	38	14	0.5	39	6.7
Nov. 8	108	19	12	5.8	50	0	14	8.0	114	54	.4	145	7.8
Nov. 27	10600	--	--	--	--	--	--	4.9	--	--	--	75	--
Dec. 6	800	8.4	8.0	1.9	36	0	7.2	5.8	86	28	.6	103	7.8
Jan. 4, 1963	116	9.0	15	7.4	56	0	25	17	119	68	.7	204	7.5
Jan. 31	28	--	15	4.5	54	0	15	--	98	56	.6	168	7.3
Feb. 27	78	--	30	12	104	0	43	48	237	124	1.3	406	8.0
Mar. 14	120	--	--	--	--	--	--	45	--	--	--	358	--
Mar. 28	110	12	10	5.6	42	0	13	9.6	121	48	.4	144	7.8
Apr. 15	67.3	--	--	--	--	--	--	20	--	--	--	225	--
Apr. 25	333	--	21	13	76	0	39	34	201	104	.9	311	7.9
May 23	30	--	22	10	96	0	27	30	189	96	1.1	300	8.1
Jun. 20	140	--	51	17	184	8	53	84	410	198	2.0	668	8.5
Jul. 1	6.5	--	-	--	--	--	--	31	--	--	--	351	--
Jul. 16	42	--	--	--	--	--	--	5.1	--	--	--	81	--
Jul. 19	13	--	8.8	1.5	38	0	13	5.8	90	28	.9	101	7.8
Aug. 14	9.3	--	11	5.0	54	0	18	10	122	48	.8	156	8.0
	7.5	--	--	--	--	--	--	11	--	--	--	149	--
Aug. 27	.2	--	--	--	--	--	--	19	--	--	--	242	--
KIAMICHI RIVER near BELZONI, OKLAHOMA													
Nov. 8, 1962	427	14	4.8	1.0	18	0	6.0	5.6	41	16	0.6	57	7.4
Dec. 6	1785	10	4.8	1.0	16	0	6.2	5.6	46	16	.6	54	7.0
Jan. 4, 1963	392	11	5.2	.7	16	0	6.4	6.6	44	16	.6	60	7.1
Jan. 31	194	11	4.0	1.5	20	0	7.8	7.4	41	16	1.0	68	7.2
Feb. 28	92	6.8	8.0	1.0	24	0	9.2	9.8	50	24	.8	88	7.3
Mar. 28	3050	17	4.0	1.5	16	0	5.8	6.3	51	16	.6	57	7.3
Apr. 25	210	13	7.2	.5	24	0	7.0	7.7	46	20	.8	77	7.5
May 23	63	16	6.4	1.0	24	0	5.8	6.4	47	20	.6	70	7.5
Jun. 20	73	9.6	7.2	1.0	22	0	7.4	7.1	51	22	.6	79	7.4
Jul. 19	30	11	4.0	1.9	16	0	5.4	4.4	52	18	.3	56	7.5
Aug. 14	9.4	8.4	3.2	1.9	20	0	4.0	4.2	49	16	.5	54	7.6
Sep. 11	4.9	8.4	3.2	2.4	20	0	4.3	6.0	48	18	.5	60	7.7

NOTE: All values are expressed in mg/l except pH and S.A.R., unless otherwise noted.

Source: Geological Survey [13]

Table 9

Surface Water Quality - Texas

Date	Mean Discharge (cfs)	Total Dissolved Solids (mg/l)	Chloride (mg/l)	Sulfate (mg/l)	Chlorine Demand (mg/l)	Dissolved Oxygen (mg/l)	BOD (mg/l)	pH
Red River at Index, Arkansas								
1959		706	182	123	.6	9.5	.8	7.9
1960	11,060	776	214	147	2.4	8.1	1.2	8.0
1961	10,070	880	245	179	2.2	7.9	1.0	8.0
1962	11,000	740	190	134	2.5	7.8	1.1	7.8
1963	4,173	940	235	167	3.2	7.2	2.7	7.8
Average	9,070	807	213	150	2.2	8.1	1.4	7.9
Red River at Arthur City, Texas								
1957		580	167	134	1.1	7.8	2.2	7.9
1958		775	200	121	1.9	7.0	1.4	7.8
1959		880	265	150	2.1	7.3	1.6	7.8
1960	7,605	916	252	182	2.6	7.0	.8	8.0
1961	6,354	1,080	300	214	3.7	7.6	.9	7.9
1962	7,708	815	214	160	2.3	6.8	1.1	7.8
1963	2,785	1,150	304	215	1.4	7.6	.9	7.8
Average	6,120	884	243	168	2.2	7.3	1.3	7.9
Red River at Denison Dam, near Denison, Texas								
1957		870	238	200	.9	8.2	2.7	7.8
1958		1,080	304	184	1.3	8.2	1.9	8.0
1959		1,325	415	248	1.2	8.6	.9	8.0
1960		1,220	354	246	2.3	8.0	1.0	8.0
1961	3,731	1,535	422	301	1.4	8.2	.8	8.0
1962	4,602	1,260	364	259	1.8	7.4	2.3	7.9
1963	2,060	1,260	336	256	2.0	7.8	1.4	7.8
Average	3,460	1,221	348	242	1.6	8.1	1.6	7.9
Sulphur River, U.S. Highway 67, Southwest of Darden								
1957		305	81	40	3.3	7.9	1.4	7.6
1958		218	43	37	3.2	7.0	2.0	7.5
1959		254	53	40	3.2	7.5	1.0	7.4
1960		224	34	39	4.3	7.8	1.7	7.8
1961		257	55	37	4.3	7.2	1.2	7.6
1962		202	31	35	4.1	7.3	1.2	7.5
1963		275	54	43	3.8	6.6	2.3	7.6
Average		248	50	39	2.7	7.3	1.5	7.6
Sulphur River, U.S. Highway 271, Southeast of Johnson								
1957		214	19	44	2.0	6.9	1.9	7.6
1958		278	33	58	1.9	6.2	1.0	7.6
1959		273	27	58	2.9	6.7	1.2	7.5
1960		273	26	62	3.5	6.2	1.4	7.8
1961	890	328	36	73	3.0	6.7	1.8	7.7
1962	1,146	293	29	60	3.8	5.6	1.0	7.6
1963	210	495	50	112	2.6	5.9	2.1	7.6
Average	750	307	31	67	2.9	6.3	1.5	7.6
White Oak Bayou, State Highway 26, North of Omaha								
1957		608	269	75	5.0	7.5	2.2	7.2
1958		304	98	46	4.5	6.7	1.5	7.4
1959		387	125	60	4.5	6.8	1.2	7.2
1960		272	80	53	5.3	6.4	1.2	7.5
1961		344	105	63	5.2	6.4	1.5	7.2
1962		233	67	43	6.2	6.0	1.0	7.1
1963		621	197	101	4.8	4.9	.9	7.0
Average		395	134	63	5.1	6.4	1.4	7.2
Little Cypress Creek, U.S. Highway 59, South of Jefferson								
1957		127	36	16	3.1	7.8	2.3	7.2
1958		123	41	17	2.9	7.2	1.7	7.6
1959		151	52	17	2.7	7.2	.7	7.2
1960		165	53	19	4.2	7.0	.7	7.4
1961		138	44	16	3.6	7.2	1.0	7.2
1962		146	45	19	3.0	7.6	.9	7.3
1963		252	91	21	3.4	7.7	.9	7.2
Average		157	52	18	3.3	7.4	1.2	7.3
Cypress Creek, U.S. Highway 59 in Jefferson								
1957		76	19	18	2.8	7.8	3.1	7.1
1958		81	18	17	2.9	6.9	1.6	7.3
1959		103	27	22	2.3	7.4	.9	7.1
1960		101	29	15	3.4	7.2	.8	7.2
1961		100	23	17	2.7	7.5	1.0	7.2
1962		127	33	21	2.1	7.7	.9	7.0
1963		125	34	19	2.4	8.0	.9	7.1
Average		102	26	18	2.7	7.5	1.3	7.1

Source: Analysis by *Texas State Department* of Health; Compilation by National Engineering Company.[15/]

NOTE: All values are arithmetic mean of periodic samples.

11. PRESENT WATER QUALITY PROBLEMS

a. Natural Pollution

(1) Natural pollution is the most extensive and serious pollution problem in the Red River basin. Natural brine (NaCl), gypsum ($CaSO_4$), and other soluble mineral deposits in the basin above Lake Texoma have degraded over 1,000 miles of the main stem (upper and lower Red River), 500 miles of tributary streams and all major reservoirs in the upper basin, including Lake Texoma. Ten major sources of natural brine, listed in table 10, contribute about 2,350 tons per day of chlorides to these streams, representing from 40 to 50 percent of the total salt load in the river and in Texoma Reservoir. The combined flow of these emissions, however, represents less than 1 percent of the average total streamflow of the basin.

(2) Gypsum deposits in the upper basin cause a high concentration of sulfates in the Red River. These gypsum deposits are widespread and frequently interbedded with salt deposits. In addition, surface waters of the main stem are generally hard due to a high calcium and magnesium carbonate content.

(3) The presence of Lake Texoma, however, has a major effect on stream quality in the main stem. The effects of storage and mixing with higher quality water from tributary streams is quite evident in flows released from the reservoir. Records indicate as much as 30 percent reduction in average mineral concentrations. In the lower basin below the reservoir there is a gradual improvement in quality through dilution flows from major tributary streams.

(4) Salt content of the Red River varies significantly in time periods through variation in rainfall and runoff from the tributary streams. An example of this may be found in gage records at Index, Arkansas. 8/ During a two year period, October 1960 to September 1962, the weighted average chloride concentration at the gage was only 173 mg/l. However, 6,709,300 acre-feet of the 15,230,000 acre-feet of water passing this point during this period contained chloride concentrations in excess of the 250 mg/l limit for drinking water established by the Public Health Service. The 8,520,700 acre-feet with chloride concentrations less than 250 mg/l passed this point during short periods of relatively high flow. From this, it is evident that water of acceptable quality in this area of the lower basin is only available during several brief intervals of 20 to 25 days each during the year.

(5) As evidenced by the use spectrum shown in table 11, the presence of natural mineral pollution in the river is suppressing the water use from the main stem of the Red River. This limits industrial growth and, largely due to a reduction in crop yields and the ability to raise high value-low salt tolerant crops, reduces farm income in adjacent areas.

Table 10

Major Natural Sources of Brine
Red River above Denison Dam

Area No.	Salt Source Area	Identifying Community	Description Type Emission, Extent, Size	Approximate Concentration of Brine as Cl (mg/l)	Chloride Load Tons/Day Average	Estimated Concentrated Brine Flow (cfs)
V	Brine Spring, Okla.	Estelline, Tex.	75-foot dia; constant flow 1959-62	25,000	375	5
VI	Elm Fork, Oklahoma	Carl, Okla.	Numerous seeps and small springs near mouths of three canyon streams (tributaries to Elm Fork of Red River) about 1 mile apart.	190,000	250	1
VII	North Fork, Wichita River, Texas	Paducah, Tex.	Several large springs, numerous seeps and salt plains, mostly on 2-mile stretch above mouth of Salt Creek of North Wichita River.	20,000	200	2
VIII	South Fork, Wichita River, Texas	Guthrie, Texas	Several large springs and numerous seeps along 2-mile stretch on South Wichita River.	4,000-27,000	200	2
IX	Middle and North Fork, Pease River, Texas	Childress, Tex.	Numerous seeps along 2-mile stretches of both North Pease and Middle Pease Rivers.	10,000-20,000	350	2
X	Middle Fork, Wichita River, Texas	Paducah, Texas	One large spring and several small seeps along 2-mile stretch of Middle Wichita River.	2,000-4,000	50	1
XI	Prairie Dog Town Fork, Texas	Brice, Texas	Numerous brine seep areas along Prairie Dog Town Fork of Red River, mostly at mouths of tributary streams.	4,000-32,000	175	2
XIII	Jonah Creek, Texas	Childress, Tex.	Salt plains, one large and numerous small brine springs in stream bed along edge of Jonah Creek for a 3-mile stretch above mouth.	27,000-40,000	450	4
XIV	Salt Creek, Texas	Childress, Tex.	Numerous small seeps in stream bed along 2-mile stretch above mouth.	30,000	150	2
XV	Little Red River, Texas	Turkey, Texas	Numerous small seeps & springs in stream bed at upper end of Little Red River for about 1-mile stretch of both North & South branches.	100,000-150,000	150	1

Source: Public Health Service [8], Corps of Engineers [16], and Geological Survey [17]

Table 11

Use-Concentration Spectrum 1/

Use	Dissolved Solids (mg/l)	Sulfates (mg/l)	Chlorides (mg/l)	Carbonate Hardness (mg/l)
Stock and wildlife	2500	100	1500	-
Food canning and freezing	850	20-60	760	100
Domestic water supply	500	250	250	100
Carbonated beverages	850	250	250	200
Food equipment washing	850	-	250	10
Irrigation 2/	1000-1300	200	250	-
Steel making	-	-	175	50
Textile process	100	100	100	50
Brewing	500	-	80	-
Paper manufacturing, Kraft pulp	300	-	200	100
Paper manufacturing, soda pulp	250	-	75	100
Paper manufacturing, ground wood pulp	500	-	75	200

1/ Suggested maximum tolerances of chemical constituents, by use.
2/ See Appendix VI, Figure 3.

Source: Public Health Service 12, 18/ and George W. Burke, Jr., 19/

(6) Turbidity is a major problem in the Red River. The soils of the bed, banks and floodplain of the river are largely sand and silt. In many areas along the stream the plant cover is sparse, particularly in farming areas. The presence of salt in the river has generally suppressed grass cover on the banks. As a result, erosion during heavy rainfall periods causes a high sediment concentration in the stream. The muddy condition of the river damages its use for recreation and for fish and wildlife propagation, and is detrimental to aesthetics.

b. Municipal Pollution

Waste discharges to streams of the basin total about 63 mgd from 137 municipal systems, as shown in table 12. Approximately one-half the total effluent from urban areas (by volume) is discharged to streams of the basin without adequate prior treatment. Localized areas of dissolved oxygen depletion and unsightly conditions resulting from untreated or inadequately treated sewage occur downstream from these discharges. In these areas, aesthetics are degraded and propagation of fish and recreation uses are damaged. Some receiving streams have a high nutrient (nitrate and phosphate) content and high coliform bacterial count which have been attributed to municipal sewage. Intermittent flow of receiving streams contributes to the health hazard and aesthetics problem.

c. Industrial Pollution

(1) A significant portion of the chloride problem in the main stem of the Lower Red River basin can be attributed to the extensive oil producing operations in the basin above Denison Dam in Texas and Oklahoma. There are approximately 160 oil fields, and 7 refineries within a 25-county area. An undetermined quantity of brine and oil waste is being discharged to streams of the basin, as determined through recent surveillance by the Federal Water Pollution Control Administration and the Geological Survey. 22/ Most of the pollution occurs as the result of water flooding operations, line breaks, spills from open brine pits, operation accidents, and leaching of brines from soils in the oil field areas. Some brine pollution of fresh ground water strata and surface water is resulting from water flooding operations in areas where previously unknown and abandoned wells have not been properly plugged.

(2) In addition to the brine pollution of the main stem, oil field brine pollution is evident on various tributaries. In many areas, the degradation results as much from leaching of past salt deposits as from new brine releases to the streams. Principal tributaries in the lower basin affected by oil field pollution are

Table 12

Status of Pollution Control Facilities

City	Est. Pop. Served	Av. Daily Flow (mgd)	Receiving Stream	Existing Facilities
LOUISIANA				
Alexandria	39,770	4.00	Red River	None *
	200	.02	Bayou Rigolette	Secondary
	50	.01	Bayou Boeuf	Secondary
	200	.02	Bayou Robert	Secondary
	200	.02	Bayou Boeuf	Secondary
England AFB	5,000	.50	Red River	Secondary
Arcadia	1,785	.10	Saline Bayou to Red River	Secondary *
	100	.01	Saline Bayou to Red River	Secondary
Bossier City	28,500	2.90	Red River	None *
	200	.02	Red River	None *
Barksdale AFB	8,413	.84	Red River	None *
Caddo Parish SD 2	600	.06	Twelve Mile Bayou	Secondary
Caddo Parish SD 5	12,000	1.20	Twelve Mile Bayou to Cross Lk.	Secondary
Cotton Valley	860	.09	Bayou Dorcheat	Primary *
	275	.03	Bayou Dorcheat	Secondary
Chatham	833	.08	Caster Creek	Secondary
Colfax	1,930	.19	Red River	None *
Coushatta	1,000	.10	Red River	None *
Cullen	2,150	.21	Bayou Dorcheat	Secondary
Doyline	1,000	.10	Bayou Dorcheat	Secondary
N. Hodge	875	.09	Dugdemona Creek	Secondary
Jena	2,000	.20	Hemphill Ck. to Catahoula Lake	Secondary
Jonesboro	3,750	.31	Little Dugdemona Creek	Secondary
Mansfield	4,500	.40	Bonne Chase Ck. to Bayou Pierre	Secondary *
Marksville	3,000	.30	Red River	Secondary
Minden	9,000	.90	Bayou Dorcheat	Secondary
	3,500	.35	Bayou Dorcheat	Secondary
Mooringsport	860	.10	Caddo Lake	Secondary
Natchitoches	11,500	1.15	Red River	Secondary
Olla	1,235	.12	Chickasaw Creek to Castor Bayou	Secondary
Pineville	8,560	.85	Red River	None *
	1,020	.10	Red River	None *
Central La. Hosp.	2,400	.24	Red River	None *
State Colony	1,800	.21	Flagon Bayou	Secondary
State Ind. School	100	.01	Flagon Bayou	Secondary
Plain Dealing	1,100	.11	Cypress Creek	Primary *
Ringgold	900	.09	Black Lake Bayou	Primary *
Rodessa	200	.02	Red River	None *
Shreveport	160,000	16.00	Red River	None *
Southern Hills	4,800	1.00	Bayou Pierre	Secondary
Springhill	6,160	.35	Bayou Dorcheat	Secondary
Vivian	2,600	.30	Black Bayou	Secondary
Winnfield	7,000	.74	Cresote Br. to Dugdemona River	Secondary
	TOTAL	34.44		

Table 12 (Continued)

City	Est. Pop. Served	Av. Daily Flow (mgd)	Receiving Stream	Existing Facilities
ARKANSAS				
Ashdown	1,000	.13	Hurricane Ck. to Little River	Secondary
De Queen	10,600	.75	Bear Creek to Little River	Secondary
	275	.03	Bear Creek to Little River	Primary *
Dierks	1,300	.13	Saline River	Secondary
Foreman	1,000	.10	Trib. Red River	Secondary
Hope	3,700	.53	Bois d'Arc Creek	Secondary *
	1,200	.16	Bois d'Arc Creek	Secondary *
Horatio	722	.07	Pond Creek	Secondary
Lewisville	300	.04	Bodcau Ck. to Bayou Dorcheat	Secondary
Magnolia	2,800	.60	Big Ck. to Bayou Dorcheat	Secondary
	3,800	.60	Big Ck. to Bayou Dorcheat	Secondary
Southern St.College	1,600	.16	Big Ck. to Bayou Dorcheat	Secondary
Marmaduke	690	.07	Trib. Red River	Secondary
Mena	2,000	.20	Wards Creek	Secondary
Mineral Springs	751	.08	Trib. Red River	Secondary
Nashville	2,450	.22	Mine Creek to Saline River	Secondary
New Rocky Comfort	1,000	.10	Trib. Red River	Primary *
Okay	200	.02	Plum Creek	Primary *
Stamps	1,050	.12	Bodcau Creek	Primary *
Taylor	450	.04	Trib. Red River	Primary *
Texarkana	19,800			
(see Texarkana, Texas)	(62,100)	4.10	Nix Creek	Secondary
Waldo	1,450	.15	Creek to Dorcheat Creek	Secondary
	TOTAL	8.40		
OKLAHOMA				
Antlers	2,080	.15	Beaver Creek	Secondary
Atoka	2,200	.22	Muddy Boggy Creek	Secondary *
Boswell	875	.05	Trib. Red River	Secondary
Broken Bow	1,600	.16	Haiky Creek	Secondary
Caddo	765	.02	Caddo Creek to Blue River	Secondary
Calera	692	.07	Trib. Red River	Secondary
Clayton	600	.06	Kiamichi River	Secondary
Coalgate	800	.06	Caney Ck. to Muddy Boggy Creek	None *
Colbert	900	.09	Trib. Red River	Secondary
Durant	9,500	1.00	Mineral Bayou	Secondary *
Fort Towson	750	.08	Trib. to Lake Gary	Secondary
Hugo	2,590	.26	Trib. of Kiamichi River	Secondary
	3,700	.37	Horse Creek	Secondary
Idabel	5,200	.25	Mud Creek	Secondary
Indiahoma	100	.01	Post Oak	Secondary
McCurtain	528	.05	Owl Creek	Secondary
Roff	638	.06	Trib. Red River	Secondary
Soper	720	.07	Boggy Creek	Secondary
Stonewall	475	.03	Buck Ck. to Clear Boggy Creek	Secondary
Stringtown	400	.04	Trib. to Muddy Boggy Creek	Secondary *
Penitentiary	200	.02	Trib. to Muddy Boggy Creek	Secondary
Talihina	700	.13	Kiamichi River	Secondary *
Valliant	660	.07	Garland Creek	Secondary
Wapanucka	500	.05	Clear Boggy Creek	Secondary
	TOTAL	3.37		

Table 12 (Continued)

City	Est. Pop. Served	Av. Daily Flow (mgd)	Receiving Stream	Existing Facilities
TEXAS				
Atlanta	3,900	.30	Black Bayou	Secondary *
Avinger	200	.03	Br. Cypress Creek	Primary *
Blossom Prairie	545	.05	Sulphur River	Secondary
Bogata	800	.05	Mustang Ck. to Sulphur River	Secondary
Bonham	7,000	.75	Bois d'Arc Creek to Red River	Secondary
Clarksville	3,600	.24	Langford Creek to Sulphur River	Secondary *
Commerce	4,500	.65	Creek to Sulphur River	Secondary
Cooper	1,800	.12	Trib. to Sulphur River	Secondary *
Daingerfield	3,000	.28	Beavers Creek	Secondary *
DeKalb	2,000	.10	Sulphur River	Secondary
Denison	4,000	.14	Iron Ore Creek to Red River	Secondary
	2,500	.12	Little Shawnee Ck. to Red River	Secondary
	11,000	.80	Paw Paw Creek to Red River	Secondary
Deport	555	.03	Mustang Creek to Sulphur River	Primary *
Detroit	676	.07	Cuthand Creek	Secondary
Dodd City	239	.02	Bois d'Arc Creek	Secondary
Gilmer	4,200	.32	Little Cypress Creek	Secondary *
Honey Grove	1,700	.05	Creek to North Sulphur River	Secondary
Hooks	2,000	.25	McKinny Bayou	Secondary
Howe	300	.02	Creek to Red River	Secondary
Hughes Springs	1,700	.09	Cypress Creek	Secondary *
Jefferson	2,900	.23	Cypress Creek	Primary *
Ladonia	700	.04	Pecan Ck. to Middle Sulphur R.	Secondary
Linden	1,000	.06	Creek to Caddo Lake	Primary *
	400	.03	Caddo Lake	Secondary
Lone Star	2,300	.50	Lake O'The Pines	Secondary
Maud	951	.10	Trib. Red River	Secondary
Mount Pleasant	8,000	1.10	Harts Creek to Cypress Creek	Secondary
Mount Vernon	1,200	.08	Trib. to White Oak Creek	Secondary *
Naples	1,400	.07		Secondary
Nash	1,117	.11	Wagoners Creek to Sulphur River	Secondary
New Boston	2,800	.20	Big Creek	Secondary
Omaha	700	.04		Secondary
Ore City	600	.04	Trib. to Red River	Secondary *
Paris	24,800	2.00	Pine Creek	Secondary
Pecan Gap	278	.03	South Sulphur River	Secondary
Pittsburg	3,700	.30	Cypress Creek	Secondary *
Roxton	1,800	.18	Trib. to North Sulphur River	Primary *
Savoy	400	.03	Bushy Creek	Secondary
Sherman	24,700	2.00	Post Oak Creek	Secondary
Sulphur Springs	7,000	.60	White Oak Creek	Secondary
	2,300	.23	White Oak Creek	Secondary
Talco	900	.05	Creek to Sulphur River	Primary *
Texarkana (see Texarkana, Ark.)	42,300	4.00	Nix Creek	Secondary
Wake Village	1,000	.07	Davis Creek	Secondary
Waskon	1,200	.07	No discharge (percolation)	Secondary *
Windom	218	.02	Trib. Sulphur River	Secondary
Wolfe City	1,000	.08	Trib. to Sulphur River	Secondary
	TOTAL	16.74		
	BASIN TOTAL	62.95		

* Inadequate

Source: Public Health Service[20/]
Federal Water Pollution Control Administration [21/]

Paw Paw Creek in the Cypress Creek basin of Texas, Bayou Dorcheat in Arkansas, and Little River (above Catahoula Lake) and Black Bayou in Louisiana. Localized areas are also located in other sections of northeast Texas and northwest Louisiana. The high chloride concentration in tributary waters precludes their use for municipal, industrial, and agricultural pruposes.

(3) A number of the streams in the Lower Red River basin foam and are highly colored as the result of paper mill effluents being released to them. Principally affected streams at present are Bayou Bodcau and Dugdemona Bayou in Louisiana. Treated effluents from the paper mills, averaging 25 to 35 mgd, contain from 400 to 1,500 units of color; approximate chemical quantities of 700 mg/l chlorides, 200 mg/l sulfates, and 1,300 mg/l total dissolved solids; and organic concentrations of about 35 mg/l. Where streamflows are inadequate to properly dilute highly mineralized effluents and assimilate the organic wastes, return flows degrade the aesthetics of the affected streams, limit their usefulness for recreation, and virtually eliminate their further use for municipal and industrial water supply.

(4) During the five years, 1962 through 1966, eleven fish kills ranging in intensity from light to heavy have occurred in Cypress Creek and Lake O' The Pines Reservoir downstream from Daingerfield, Texas. 21/ All were attributed to industrial wastes containing metals or chemicals. These materials were present in concentrations toxic to fish. Conditions indicate that the pollution resulted from the release of inadequately treated wastes from the steel industry in the Daingerfield area.

(5) Pollution problems exist in other areas where industries have inadequate waste treatment facilities. Oils, greases and toxic materials in industrial wastes are allowed to enter streams of the basin. Areas where this pollution problem is most prevalent are refinery areas in the vicinity of Marshall, Texas and Shreveport, Louisiana; and Ordnance operations near Texarkana, Texas.

(6) Food and kindred industries engaged in the processing of pork, beef and poultry products are located in principal cities throughout the basin. Most plants discharge wastes through the municipal treatment facilities and do not, in themselves, cause stream pollution problems under these conditions. They do, however, impose heavy organic loads on treatment facilities. At least 10 percent of overloaded treatment plants, as listed in paragraph b, can be attributed to this industry.

(7) Sand and gravel operations have caused isolated problems of water pollution in basin streams. Dumping of excavated materials has caused increased turbidity in limited reaches of receiving streams.

d. Agricultural Pollution

(1) The use of herbicides and pesticides for weed and insect control in agricultural areas has polluted streams in some sections of the basin. Pollution has resulted through either direct application on the streams or by irrigation return flows. Fish kills attributable to agricultural spraying have been reported.

(2) Although considered to be a minor problem in the Lower Red River basin, irrigation return flows cause some general degradation of water quality in receiving streams. The volume of irrigation return flow is substantially less than the volume of water applied. However, mineral concentrations are increased. Dissolved solids, sulfates, chlorides, hardness and turbidity are generally increased. Fertilizers containing plant nutrients, such as nitrogen and phosphorus, are carried to the streams by return flows. The nutrients promote growth of aquatic weeds and interfere with some types of aquatic life.

(3) In 1963, approximately 80,000 acre-feet of water was used for irrigation of about 42,000 acres of cropland in the Lower Red River basin, as described in Appendix VI. The actual return flow quantities are unknown. It can be assumed however, that at least one-third of the water used was returned to streams of the basin by overflow, runoff or seepage. If a proper salt or chemical balance is maintained in the soil, the chemical concentrations in the water which is returned to the stream are increased approximately 3 times.

e. Other Water Quality Problems

The Red River Backwater Area near the mouth of the stream presents a particularly complex water quality situation. In this area, the annual inundation from the Mississippi and Red Rivers' overflow produce favorable areas for propagation of fish and excellent wintering ground for ducks and other waterfowl. Drainage resulting from navigational and flood control projects have altered and will alter the quantity and quality of the water resource in this area and in many cases damage the usefulness of the fish and wildlife resource.

12. CRITERIA FOR DETERMINATION OF FUTURE WATER QUALITY CONTROL NEEDS

a. Use of the Streams

As defined by the states, 23-26/ streams of the Lower Red River basin are used for municipal, industrial, rural and irrigation water supply; for fish and wildlife propagation; for recreation, including sport fishing, boating and swimming; for power, aesthetics,

navigation, assimilation of treated wastes, and transport of treated waste and surface drainage. Specific uses of the major interstate streams, as designated by the states, as shown in table 13.

b. Water Quality Requirements for Various Water Uses

In projecting stream conditions to satisfy future requirements, certain indicators have been selected in this study as a measure of water quality, based on types and quantities of natural pollution and projected return flows. The indicators include dissolved oxygen, biochemical oxygen demand, total dissolved solids, chlorides, sulfates, temperature, pH, nutrients, hardness, color, and other selected parameters. A comparison between the water quality requirements of the various water uses and several of the quality indicators is shown in tables 11 and 14.

c. Water Quality Standards

The states of Louisiana, Arkansas, Oklahoma and Texas have established and adopted water quality control standards for all interstate streams in the Lower Red River basin, designed to protect the water uses previously described and listed in table 13. Texas has also adopted water quality standards for intrastate streams. The criteria established by the states has been used in computations to determine flow regulation and other quality control needs developed in connection with this study. A partial listing of selected criteria for the major interstate streams is presented in table 15. The standards, however, include a number of other parameters than those shown in the table, of which temperature, toxic material and bacteria are probably the most important.

Table 13

Water Uses of Interstate Streams

	LOUISIANA						ARKANSAS						OKLAHOMA				TEXAS				
	Red River	Caddo Lake (Cypress Creek)	Bodcau Bayou	Bayou Dorcheat			Red River	Little River	Sulphur River	Bodcau Bayou	Bayou Dorcheat		Red River	Little River			Red River	Sulphur River	Cypress Creek	McKinney Bayou	
Aesthetics	X	X	X	X			X	X	X	X	X		X	X			X	X	X	X	
Public Water Supply	X	X		X			X	X					X	X			X	X	X	X	
Industrial Water Supply	X	X	X	X			X			X			X	X			X	X	X	X	
Fishing	X	X	X	X			X	X	X	X	X		X	X			X	X	X	X	
Wildlife	X	X	X	X			X						X	X			X	X	X	X	
Hydropower													X	X							
Agricultural	X			X							X		X	X				X	X	X	
Navigation	X	X					X	X					X								
Watershed Run-off	X	X	X	X			X	X	X	X	X		X	X			X	X	X	X	
Waste Assimilation	X	X	X	X			X	X	X	X	X		X	X			X	X	X	X	
Irrigation	X						X						X	X			X	X	X	X	
Recreation	X	X	X	X			X	X	X	X	X		X	X			X	X	X	X	

Source: Arkansas Pollution Control Commission 23/, Texas Water Quality Board 24/, Louisiana Stream Control Commission 25/, and Oklahoma Water Quality Coordinating Committee 26/

Table 14

Dissolved Oxygen and Biochemical Oxygen Demand
Use-Concentration Spectrum

Type of Use	Dissolved Oxygen	5-day 20°C BOD (mg/l)
Domestic	$\geq$ 5.0	0.75-2.5
Industrial	0-1.5	<25.
Fish & Wildlife	$\geq$ 4.0	< 5.0
Trout Streams	$\geq$ 5.0	< 5.0
Recreation	-	2.0-2.5
Irrigation	-	-
Navigation	-	-
Hydropower	-	-

Note: Use-concentration spectrum for minerals is shown in table 11.

Source: U. S. Public Health Service. 18/

Table 15

Water Quality Standards Selected Criteria Summary (Incomplete Listing)

	(mg/l)							
	TDS	Max. Chloride	Max. Sulphate	Max. BOD	Min. D.O.	Range pH	Color	Turbidity
LOUISIANA								
Red River	-	250	-	-	-	6.0-8.5		
Caddo Lake	(To Be Established)			-	-	6.0-8.5		
Bayou Bodcau	(To Be Established)			-	-	6.0-8.5		
Bayou Dorcheat	(To Be Established)			-	-	6.0-8.5		
ARKANSAS								
Red River	(To Be Established)			-	4.0	6.0-9.0	Substantially Free	Substantially Free
Little River	(To Be Established)			-	4.0	6.0-9.0		
Sulphur River	(To Be Established)			-	4.0	6.0-9.0		
OKLAHOMA								
Lower Red River (Main Stem)	1,040*	347*	240*	-	4.0	6.5-8.5		
Little River	56*	7*	5*	-	4.0	6.5-8.5		
*Weighted Average Quality (Interim Standard)								
TEXAS								
Lower Red River (Main Stem)	1,080	365	244	4.0	4.0	6.5-8.5		
Sulphur River (Main Stem)	400	60	90	3.0	5.0	6.0-8.0		
Sulphur River (at Ark. line)	1,000	250	250	3.0	5.0	6.0-8.0		
Cypress Creek	300	80	50	5.0	5.5	6.0-8.0		
McKinney Bayou	400	60	90	3.0	5.5	6.0-8.0		
Caddo Lake	300	100	50	3.0	5.5	5.0-7.0		

NOTE: Water quality standards for each of the 4 states provide for a minimum treatment level of secondary for municipal wastes and its equivalent for industrial wastes.

Source: Arkansas Pollution Control Commission [23], Texas Water Quality Board [24], Louisiana Stream Control Commission [25], and Oklahoma Water Quality Coordinating Committee [26]

13. BASIS FOR ANALYSIS OF FUTURE NEEDS

a. General

(1) Expected growth and expansion of cities and industries in Lower Red River basin will intensify water pollution problems in some areas and create new problems in other areas. With this growth, there will be a corresponding increase in the quantity, concentration, and complexity of wastes discharged into the surface waters of the basin. Some receiving streams will have inadequate base flows to properly assimilate projected waste discharges. Below cities, large food processing industries and pulp and paper mills, treated effluents high in residual BOD and nutrients may cause critical oxygen depletion in receiving streams where mixing or dilution waters are inadequate. In certain areas fish kills and septic conditions are likely to occur. Such conditions create health hazards and are highly detrimental to further use of the stream for municipal, industrial, rural domestic, and livestock water supply; for fish and wildlife and general recreation purposes.

(2) High concentrations of total dissolved solids, chlorides and sulfates, which are detrimental to municipal, industrial and irrigation uses, will be most prevalent in the main stem of the Lower Red River and in tributary streams receiving discharges from petro-chemical industries, petroleum refineries and paper mills.

(3) With extensive expansion and new development of the pulp and paper industry throughout the basin, color will be a growing problem until technology is available for adequate treatment. Effluents from mills impart a characteristic dark brown "coffee" color to receiving streams which is detrimental to recreation use, aesthetics, and further use of the stream for municipal and industrial water supply.

(4) Thermal pollution of lakes and streams is expected to steadily increase due to the discharge of heated water from industrial plants, including steam-electric plants that are rapidly growing in number and size. In general, the electric power industry represents the largest current single source of heated water discharge to inland bodies of water. There are a number of effects that result from thermal pollution which are harmful to our environment.

(5) The following paragraphs will summarize basic elements of the quality analyses, including projected wastes, stream characteristics, hydrologic criteria, and needs for streamflow regulation and other pollution control measures.

b. Projected Wastes

(1) The projected quantity of waste discharge to the streams was estimated as a percentage of water use. In this study, the percent of municipal and industrial return flow was estimated to average about 70 percent.

(2) The projected quality of municipal return flows was based on assumed per capita contributions of 0.23 pounds per day of total dissolved solids, 0.013 pounds per day of chlorides, and 0.18 pounds per day of biochemical oxygen demand (BOD). It is assumed that treatment will be provided to remove 90 percent of the BOD. Based on a typical municipal sewage having an untreated concentration of 286 mg/l BOD, the concentration of BOD in the treated effluent to the stream would be 29 mg/l.

(3) Projected industrial return flow quality is difficult to evaluate because of its variability with time, type of manufacturing process, type of product, production rate, cost of water, and many more factors. For purposes of this report, however, estimates were made of the concentrations of various pollutants resulting from industrial operations by industry groups (Standard Industrial Classification two digit categories 13, 14, and 20 through 39). In the estimates of conservative pollutants, the assumption was made that the concentrations of dissolved substances in the source water are additive with the industrial contributions. For the degradable pollutant use (BOD), it was assumed that industries which contribute this type of waste would provide equivalent treatment of municipal waste that has been treated to remove 90 percent of the first-stage carbonaceous BOD. The BOD contributions from industrial operations (after treatment) would range from 40 to 150 mg/l.

(4) No measurable return flow is expected to result from rural domestic and livestock water use.

(5) For irrigation, it was assumed that water would be applied in a manner that will prevent mineral buildup in the soil. Projected irrigation return flow would have mineral concentrations approximately 3 times as high as concentrations in the source water.

(6) Projected municipal and industrial return flows by areas for the years 1980, 2000, 2030, and 2080 are summarized in table 16.

Table 16

Projected Municipal and Industrial Return Flows
(million gallons per day)

Area	1980	2000	2030	2080*
1	3.0	23.1	44.2	84.4
2	37.5	38.5	40.7	42.8
3	22.1	30.7	46.1	84.9
4	66.8	92.4	112.0	162.0
5	40.6	73.2	98.1	135.1
6	111.8	179.9	276.3	468.1
7	21.5	25.1	33.2	53.6
8	61.5	71.1	90.1	137.8
Totals	364.8	534.0	740.7	1168.7

* Based on extrapolation of projected 2030 water requirements.

c. Stream Characteristics

(1) The streams which receive treated wastes from cities and industries provide further treatment by natural processes. These natural processes include the digestive or "purifying" action of oxygen-demanding bacteria, the physical dilution of mineral and chemical substances, and cooling of heated water. Dissolved oxygen is one of the most important constituents in water used to transport wastes because it is essential to the existence of most forms of aquatic life, including the bacteria that assimilate, or "digest", the organic material in the waste flows. Dissolved oxygen can be used as a major indicator of the overall quality of a surface stream. The concentration of dissolved oxygen present in a stream is decreased during digestion of organic wastes. Replenishment of the oxygen, or reaeration, is accomplished by absorption from the atmosphere and photosynthesis. It is a function of the biological, physical, and hydraulic properties of the stream. The net effect of

a stream's response to a pollutional load may be shown by a graphical illustration (plate XI-3) of the deoxygenation-reaeration relationship. The oxygen-sag equation of Streeter and Phelps expresses this relationship on the waste assimilation capacity of a stream.

(2) Physical, chemical, and biological properties of streams are closely related to temperature. Growth of taste-and-odor-producing bacteria in lakes and impoundments may be stimulated by warm temperatures caused by thermal pollution. Dense bacteria growth can add to costs of water purification treatment. Not the least important of the effects of waste heat disposal is the reduction in the utility of the water for further cooling. Temperature affects the ability of water to sustain aquatic life. Oxygen is less soluble in warm water than in cold water, and the quantity of oxygen in solution may be further lowered as increased temperatures accelerate biological activity.

d. Hydrologic Criteria

For quality studies the base flow of the streams was considered to be the low natural runoff expected to be exceeded 95 percent of the time. (Once in 20 years drought recurrence interval). Low flows were estimated on unit runoff (cfs per square mile) for streams where gage data was not available. Monthly base flows were determined from a distribution of median monthly flows expressed in terms of the low yearly flow.

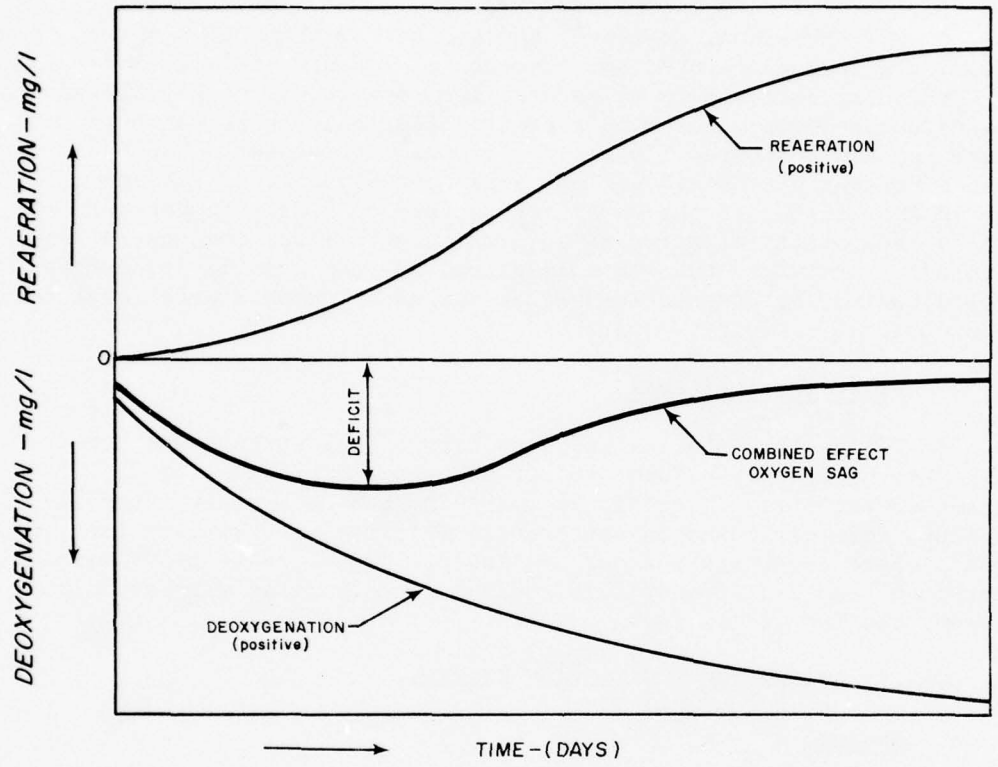
14. QUALITY EVALUATION - TRIBUTARY STREAMS

a. General

Quality analyses were made on all streams in the basin where significant waste discharges are projected, both organic and inorganic in nature. Results of these studies indicate a number of severe problem areas where stream flows for assimilating wastes are inadequate. The affected streams are listed in table 17 and described in the following paragraphs.

b. Sulphur River

(1) Detailed studies, in connection with this report, have been made on two segments of the Sulphur River, the 44 mile reach of the main stem downstream from Texarkana Reservoir and a 10 mile reach of the South Sulphur River between the city of Commerce and the headwaters of the authorized Cooper Reservoir. The intervening areas were studied in detail in connection with a prior report 28/ on the Cooper project.



COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS

DISSOLVED OXYGEN SAG

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
JUNE 1968

PLATE XI-3

Table 17

Net Water Quality Control Needs

Area No.	Stream	Supplemental Flow Needed With 90% Treatment (1) (mgd) 1980	2030	% Treatment (1) For BOD Control Needed Without Supplemental Flow 1980	2030
1	Kiamichi River below Hugo Reservoir, Oklahoma	62.0(2)*	90.0(2)*	--	--
2	Mountain Fork and Little Rivers below Broken Bow Res., Okla.	65.3(3)*	110.0(3)*	--	--
2	Little River below Millwood Reservoir, Arkansas	60.0(3)*	100.0(3)*	--	--
2	Bois d'Arc Creek below Hope, Arkansas	18.5(3)	20.1(3)	--	--
2	Mine Creek below Nashville, Arkansas	0	0.1	--	92
3	Mineral Bayou below Durant, Oklahoma	0.2	0.7	94	96
3	Choctaw Creek below Sherman, Texas	1.9	5.9	94	96
3	Bois d'Arc Creek below Bonham, Texas	0.8	1.7	94	96
3	Pine Creek below Paris, Texas	13.8	35.4	97	98
4	South Sulphur River below Commerce, Texas	0.1	0.3	96	98
4	Sulphur River below Texarkana Reservoir	45.0*	35.0*	98	98
4	Whiteoak Creek below Sulphur Springs, Texas	0	1.5	--	96
5	Cypress Creek below Mt. Pleasant, Texas	1.2	5.4	97	98
5	Little Cypress Creek below Gilmer, Texas	0	0.7	--	94
6	Bodcau Bayou below Springhill, Louisiana	19.4	19.4	96	96
6	Bayou Dorcheat below Magnolia, Arkansas	1.4	9.8	94	96
6	Twelve Mile Bayou below Caddo Lake, Louisiana	0	0.4	--	94
8	Dugdemona Bayou below Ruston, Louisiana	8.2	10.6	94	95

* Controlling parameter other than BOD.

(1) Percent removal of ultimate BOD.

(2) Needs developed in connection with the Public Health Service report on Southeastern Oklahoma - Southwestern Arkansas project.[27] Authorized storage to develop a yield of 90 mgd has been provided in the Hugo Reservoir to supply this need.

(3) Needs developed in connection with the Public Health Service report on Southeastern Oklahoma - Southwestern Arkansas project.[27] Authorized storage to develop a yield of 110 mgd has been provided in the Broken Bow Reservoir to supply this need.

(2) At present, treated waste effluents from the city of Texarkana, Texas-Arkansas, flow through two small interstate streams, Nix and Day Creeks, to the Sulphur River, a distance of about 24 miles. The wastes enter the Sulphur River in Arkansas at about river mile 20 above the river's confluence with the Red River. No major industrial wastes enter the Sulphur River, at present, from the Texarkana Dam in Texas to the stream's confluence with the Red River in Arkansas.

(3) For projecting future conditions, it was assumed that increased municipal and industrial wastes would be piped directly to the Sulphur River at a point below Texarkana Dam to prevent the small receiving streams from becoming an open sewer. A second waste discharge from a proposed International Paper Company plant would enter the Sulphur River in Texas near the Arkansas state line. General characteristics of the treated waste loadings to the stream would be as follows:

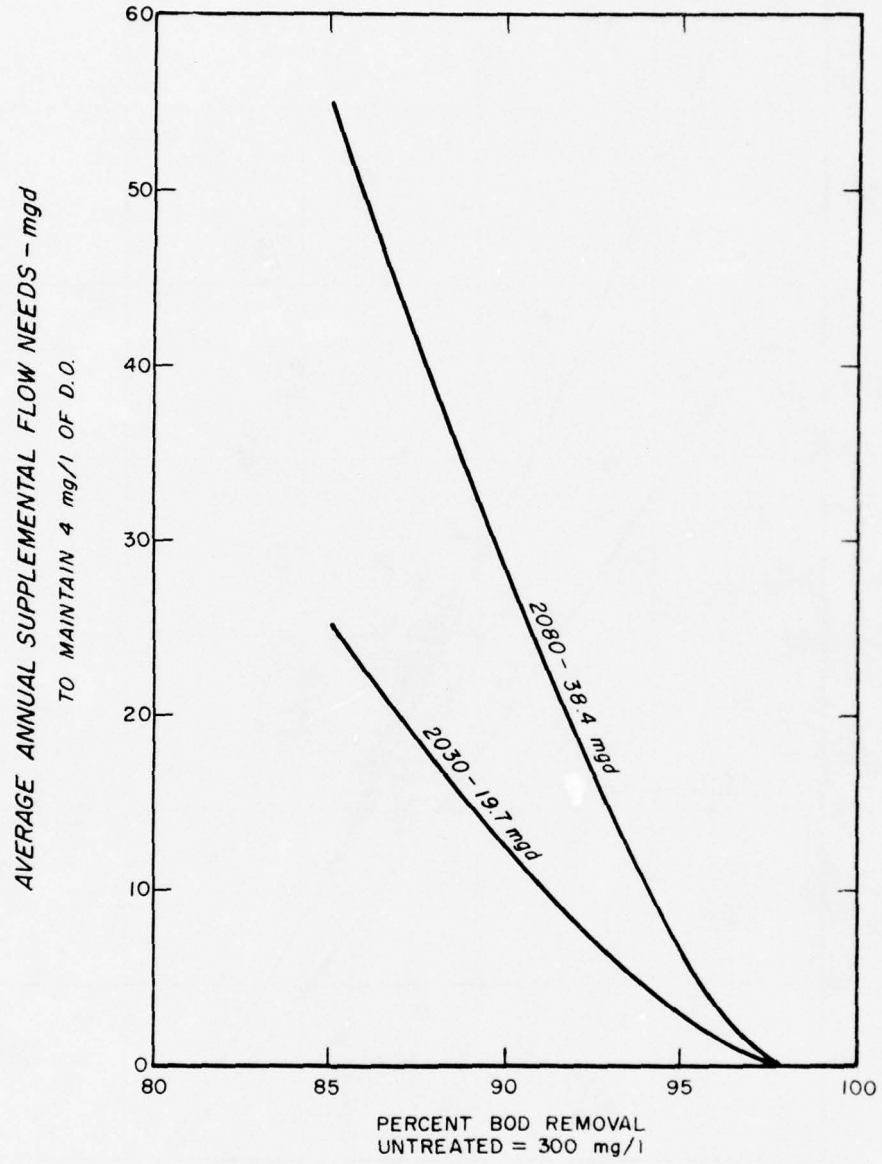
	mg/l (except color)	
	City	Paper Mill
BOD	30	35
Phosphates	10	-
Sulfates	100	225
Chlorides	70*	700
Dissolved Solids	500	1300
Color, units	20	400-1000

* Without return flows from pickle industry in Texarkana

(4) Streamflows available for assimilation of treated wastes would consist of 10 cfs (6.5 mgd) low flow release from Texarkana Reservoir plus runoff from the uncontrolled drainage area below the dam.

(5) To maintain acceptable quality in the Sulphur River and meet established stream standards, additional flows in the stream would be needed. Quantities needed for BOD control to prevent total depletion of oxygen in the stream are shown on plates XI-4 and XI-5 for various degrees of treatment. Treatment levels of 98 percent would be required to eliminate need for supplemental flow in the stream.

(6) With relocation of the outfall below the city of Texarkana, effluents from the city under current conditions would reduce concentrations of total dissolved solids and sulfates of the paper mill wastes in the stream to an acceptable level. However, to reduce concentration of chlorides to 250 mg/l (adopted standard) would require approximately 45 mgd of additional flow by the year 1980. Through dilution by the return flows from Texarkana, the

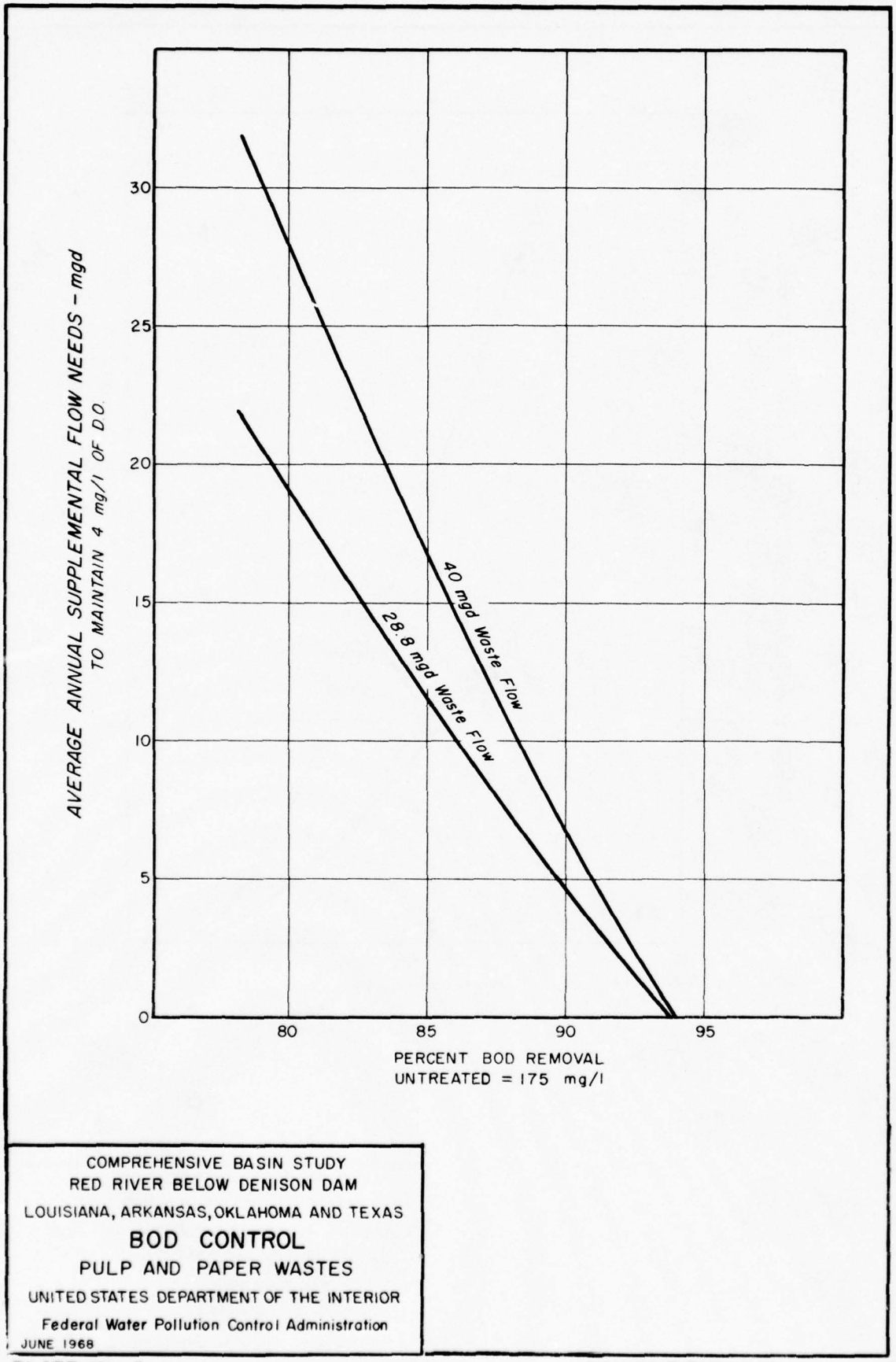


COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS

BOD CONTROL
TEXARKANA WASTES

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
JUNE 1968

PLATE XI-4



COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS

BOD CONTROL

PULP AND PAPER WASTES

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
JUNE 1968

PLATE XI-5

supplemental flow need would reduce to about 35 mgd by the year 2030. However, this benefit would be offset through expansion of the pickle industry at Texarkana. Return flows from the industry contain approximately 350 mg/l chlorides.

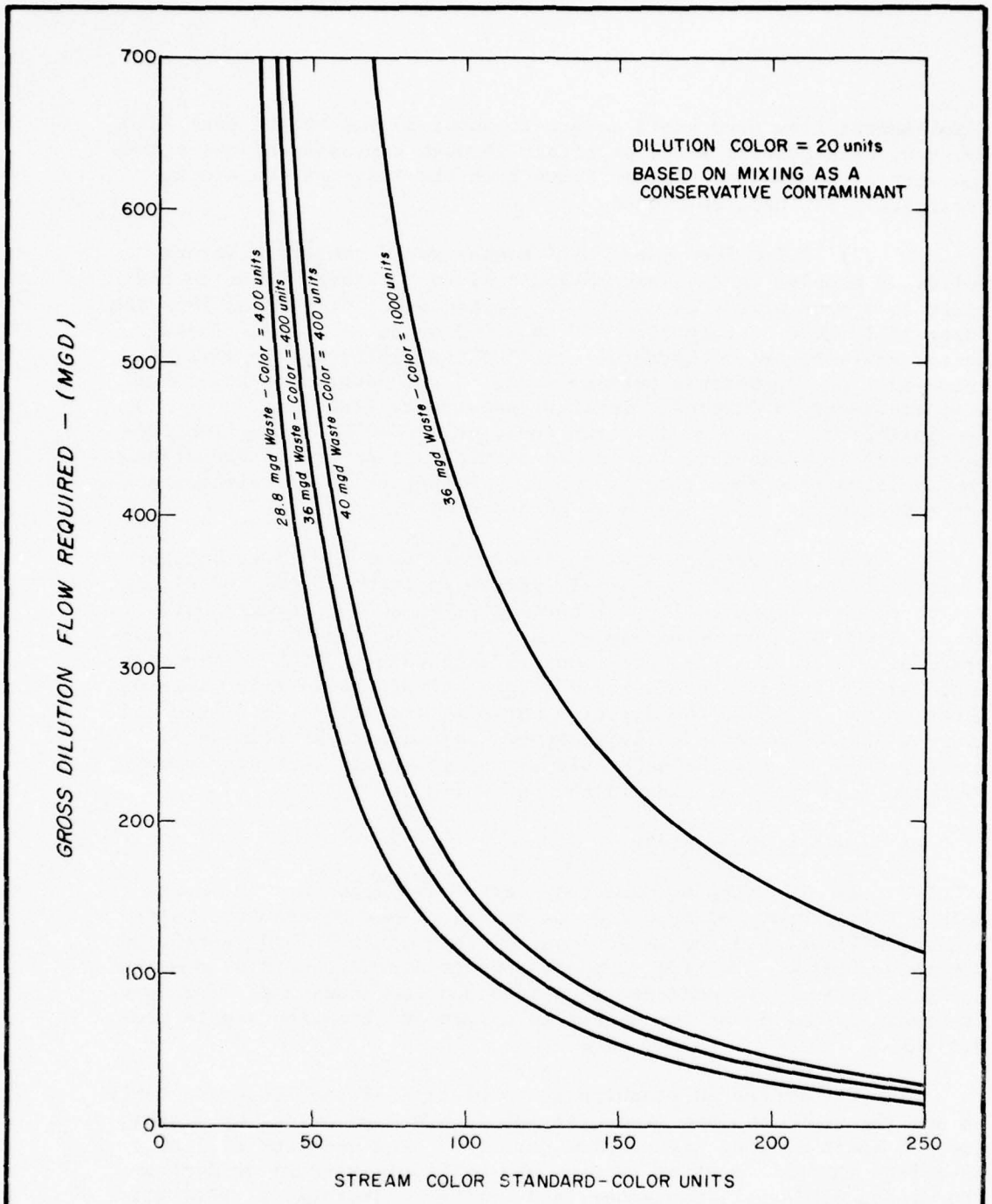
(7) Color from paper mill wastes would present a severe pollution problem in the lower Sulphur River. Natural color in the river is approximately 20 units. Projected waste discharges from the paper mill would contain from 400 to 1,000 units of color. These wastes would impart a characteristic "coffee" color to the stream. Color is a non-degradable pollutant and is not responsive to biological treatment in lagoons. Chemical treatment, like lime precipitation, or a high dilution would be needed to reduce the concentration to acceptable levels and permit further use of the stream for municipal and industrial purposes. Dilution flow requirements for reduction of color are shown on plate XI-6.

(8) The projected waste discharges from the lower Sulphur River would have little measurable effect on color of the Red River. Projected monthly mean flows of the Red River at Shreveport would exceed 1,400 mgd approximately 95 percent of the time during a recurrence of the critical drought (June 1953-February 1957), as shown on plate XI-7. Based on projected discharges from the Sulphur River of about 36 mgd in 1980, the dilution ratio in the main stem of the Red River would be about 39 to 1. However, to minimize or eliminate potential color or chloride problems, wastes should be systematically released on a basis of flow in the receiving streams.

c. South Sulphur River

(1) The city of Commerce, Texas discharges to the South Sulphur River upstream from the authorized Cooper Reservoir. This project will be used for water supply, flood control, and recreation. During periods of low flow, projected waste discharges from Commerce could be expected to degrade the stream and the headwaters of Cooper Reservoir by depleting the dissolved oxygen and creating septic conditions.

(2) Presented graphically on plate XI-8 and listed in table 18 are the gross and net needs for low flow augmentation, by months, for the South Sulphur River below Commerce. The quantity of flow needed to maintain quality exceeds the available streamflow during the months of August, September, and October. Storage to yield 0.1 mgd (110 acre-feet per year) would be needed by 1980 and 0.3 mgd (340 acre-feet per year) by 2030 to insure acceptable water quality. Treatment levels of 96 percent for BOD control would be needed to eliminate the need for supplemental flows.

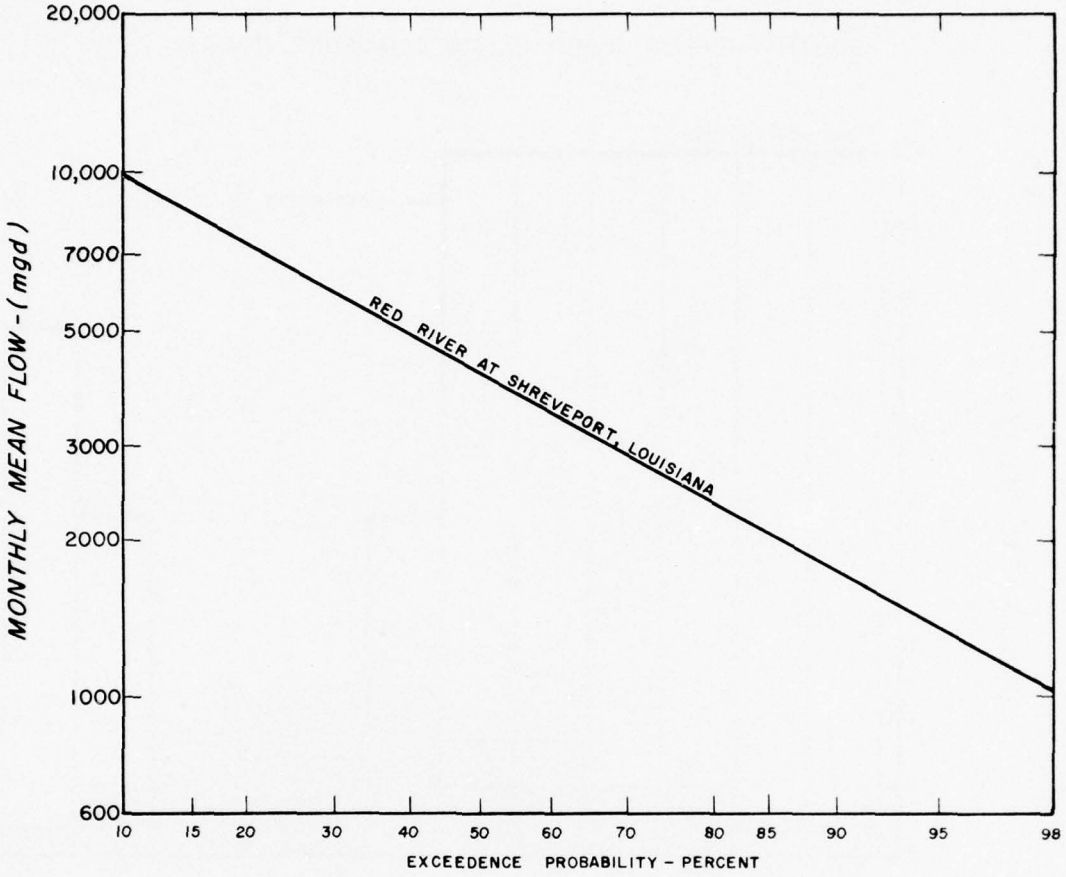


COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS

DILUTION REQUIREMENTS FOR COLOR

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
JUNE 1968

PLATE XI-6



NOTE FOR CRITICAL PERIOD
Jun 1953 – Feb 1957

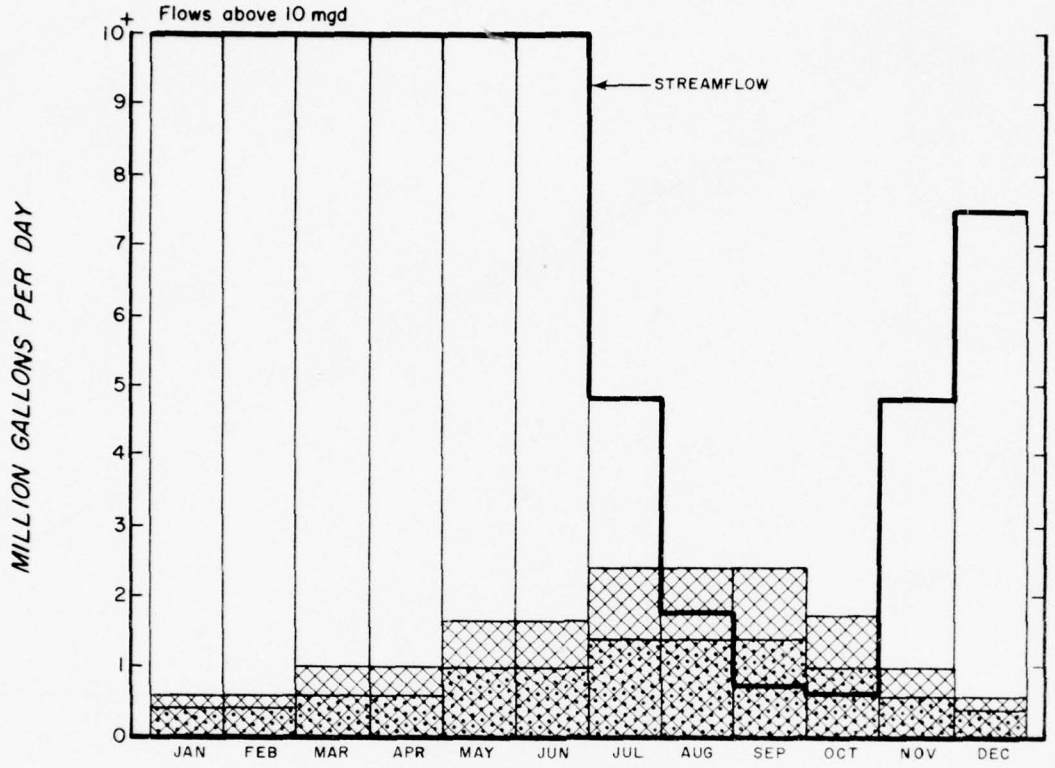
COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS

PROJECTED MONTHLY MEAN FLOW FREQUENCY

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
JUNE 1968

PLATE XI-7

SOUTH SULPHUR RIVER BELOW COMMERCE, TEXAS



LEGEND

1980 GROSS REQUIREMENTS

2030 GROSS REQUIREMENTS

COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS

SUPPLEMENTAL FLOW NEEDS

UNITED STATES DEPARTMENT OF THE INTERIOR
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JUNE 1968

PLATE XI-8

Table 18

Monthly Distribution of Supplemental Flow Needs
(mgd)

Month	Bayou Dorcheat below Magnolia, Arkansas								Bodcau Bayou below Springhill, Louisiana	
	1980		2000		2030		2080		1980 - 2080	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net
January	1	0	2	0	4	0	6	0	4	0
February	1	0	2	0	4	0	6	0	4	0
March	5	0	8	0	13	0	20	0	17	0
April	5	0	8	0	13	0	20	0	17	0
May	13	0	22	0	34	0	53	0	43	0
June	13	0	22	0	34	6	53	24	43	4
July	20	0	34	0	53	13	82	41	67	63
August	20	17	34	29	53	49	82	78	67	63
September	20	0	34	7	53	26	82	55	67	64
October	13	0	22	10	34	22	53	41	43	40
November	5	0	8	0	13	1	20	8	17	0
December	1	0	2	0	4	0	6	0	4	0
Annual Average		1.4		3.8		9.8		20.5		19.4

Month	Bois d'Arc Creek below Bonham, Texas								Sulphur River below Commerce, Texas							
	1980		2000		2030		2080		1980		2000		2030		2080	
	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net
January	0	0	1	1	1	1	1	1	0	0	1	0	1	0	1	0
February	0	0	1	1	1	1	1	1	0	0	1	0	1	0	1	0
March	1	1	1	1	1	1	2	2	1	0	1	0	1	0	2	0
April	1	1	1	1	1	1	2	2	1	0	1	0	1	0	2	0
May	1	1	1	1	2	2	4	4	1	0	1	0	2	0	3	0
June	1	1	1	1	2	2	4	4	1	0	1	0	2	0	3	0
July	1	1	2	2	3	3	5	5	1	0	2	0	2	0	4	0
August	1	1	2	2	3	3	5	5	1	0	2	0	2	1	4	2
September	1	1	2	2	3	3	5	5	1	0.7	2	1	2	2	4	3
October	1	1	1	1	2	2	4	4	1	0.5	1	1	2	1	3	2
November	1	1	1	1	1	1	2	2	1	0	1	0	1	0	2	0
December	0	0	1	1	1	1	1	1	0	0	1	0	1	0	1	0
Annual Average		0.8		1.2		1.7		3.2		0.1		0.2		0.3		0.6

d. Cypress Creek

(1) The cities of Mt. Pleasant and Pittsburg, Texas presently discharge to Cypress Creek upstream from the headwaters of Lake O' The Pines (Ferrells Bridge Reservoir). This reservoir is used for water supply, flood control and recreation. Treated municipal sewage from Mt. Pleasant flows approximately 5 miles through Harts Creek and about 18 miles through Cypress Creek to the headwaters of the reservoir (at the water supply pool level). Pittsburg discharges its waste directly to Cypress Creek about 12 miles above the reservoir. Wastes from projected urban and industrial expansion in this area are expected to reduce the quality of the stream and headwaters of the reservoir below the state standards. Additional streamflow would be needed to eliminate septic and low dissolved oxygen conditions and assure a greater base flow for fish and wildlife propagation and recreation.

(2) The need for storage for streamflow regulation is presented graphically on plate XI-9. The low natural streamflow is plotted against the quantity of flow required to assimilate the waste discharged. Low flows were based on the Cypress Creek at Pittsburg gaging station (1943-1962). Supplemental flows of 1.4 mgd (1,600 acre-feet) would be needed by the year 1980 increasing to 5.4 mgd (6,000 acre-feet) by 2030.

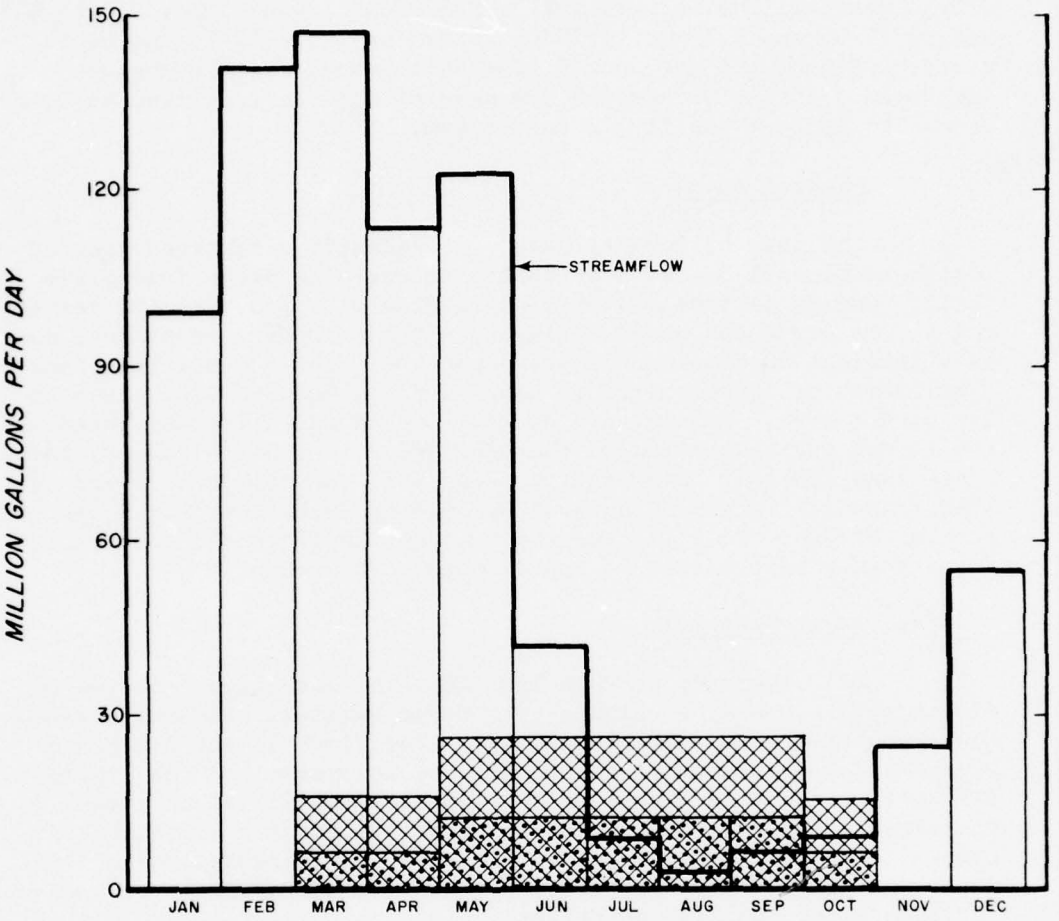
(3) Using actual historical average monthly flows for the 20-year period-of-record, the waste load projected by 2030 would cause the following failures: June - 16 percent of the time, July - 42 percent, August - 63 percent, September - 47 percent, October - 42 percent, and November - 16 percent. An analysis of daily flows for the 2030 condition indicates quality would be impaired approximately one-third of the time. In the absence of low flow augmentation, treatment levels required to protect the stream would be approximately 97 percent.

(4) Other pollution problems exist in the Cypress Creek basin, as described in paragraph 11c. These problems result from petroleum and steel industrial operations in the area. Improved industrial waste treatment facilities and other pollution control measures are needed in the Daingerfield area to prevent toxic materials from entering Cypress Creek and Lake O' The Pines. Improved oil production and refinery waste control operations are needed to provide for proper disposal of oil field brines (including subsurface disposal), greases and oils, and prevent their discharge and leaching to the streams.

e. Bois d'Arc Creek, (Texas)

Bois d'Arc Creek receives the treated effluent from the city of Bonham, Texas. Based on low flow characteristics of the Bois d' Arc Creek area and future pollutional loadings from the city of

CYPRESS CREEK BELOW MT. PLEASANT, TEXAS



LEGEND

1980 GROSS REQUIREMENTS

2030 GROSS REQUIREMENTS

COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS

SUPPLEMENTAL FLOW NEEDS

UNITED STATES DEPARTMENT OF THE INTERIOR
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PLATE XI-9

Bonham, low flow augmentation is needed to adequately assimilate the city's wastes. The net streamflow requirement would approximate 0.8 mgd in 1980, and 1.7 mgd in 2030. Shown on table 18 is the monthly distribution of the net annual flow deficiency. In the absence of supplemental flow, 94 percent BOD removal through treatment would be needed to protect quality in the stream.

f. Mineral Bayou

The town of Durant, Oklahoma presently discharges treated wastes to Mineral Bayou, a tributary to the Blue River (see plate XI-1). During periods of low flow in Mineral Bayou, the BOD remaining in the projected waste effluent, after secondary treatment, could be sufficient to cause an oxygen depletion, septic conditions, and elimination of aquatic life in Mineral Bayou and the Blue River in the Durant area. An analysis of low flow characteristics, based on the stream gaging station on the Blue River at Blue, Oklahoma, indicates that low flow augmentation needs will approximate 0.2 mgd by 1980, and will increase to about 0.7 mgd by 2030, based on 90 percent removal of BOD. To eliminate the need for supplemental flow would require treatment levels of approximately 94 percent.

g. Bayou Dorcheat

(1) The city of Magnolia, Arkansas discharges treated effluent to Big Creek, a tributary to Bayou Dorcheat near the Arkansas-Louisiana stateline (see plate XI-1). The flows in Big Creek and Dorcheat Bayou are frequently inadequate to assimilate the treated effluent. This situation causes a depletion of dissolved oxygen in the stream, destroys normal aquatic life and creates septic conditions. With projected growth of the area the increased volume of waste discharge would increase the frequency and severity of unacceptable water quality conditions.

(2) A streamflow analysis of Big Creek and Bayou Dorcheat was made based on gage records for Bayou Dorcheat near Springhill, Louisiana. Low flows were compared to the minimum streamflow requirements for adequate assimilation of the projected municipal and industrial wastes. Streamflow deficiencies are shown in table 18. In the absence of supplemental flows, treatment levels of approximately 94 percent will be needed for BOD control.

(3) As described in paragraph 11c, more stringent control measures over oil operations in the Bayou Dorcheat watershed are needed to reduce high chloride concentration in reaches of the stream in Arkansas resulting from brine discharges. A continuing major problem in this area is the leaching from and flooding of open brine pits.

h. Bodcau and Dugdemona Bayous

(1) Paper mills in Louisiana create a major tributary stream pollution problem in the Lower Red River basin with large effluents that are dark brown in color, that foam, and contain high concentrations of total dissolved solids, sulfates, chlorides and BOD. Principal among the large plants located on tributary streams in the study area portion of the basin are the International Paper Company plant at Springhill and the Continental Can Company plant at Hodge.

(2) The plant at Springhill discharges to Bodcau Bayou, an interstate stream, south of the Arkansas state line. From the mill, the dark stream flows a distance of about 60 miles to its confluence with Loggy Bayou at a point downstream from Lake Bistineau, and thence about 6 miles to the Red River.

(3) The paper mill at Hodge discharges to Dugdemona Bayou below Ruston, Louisiana. The receiving stream is polluted for a 50 mile reach to its confluence with Little River. The pollution extends over a 35 mile reach of the Little River to the headwaters of Catahoula Lake. Waters of the lake contain a high concentration of chlorides resulting from both oil field and paper mill operations.

(4) Since insufficient water resources are available in the headwaters of the two streams to provide large quantities of flow for reduction of color by dilution, further industrial waste treatment by slaked lime precipitation or other chemical treatment methods would be needed.

(5) Effluents are currently being treated in oxidation ponds for BOD reduction. These ponds are believed to be about 80 percent effective by reducing BOD concentrations from about 175 mg/l to approximately 35 mg/l. To maintain satisfactory dissolved oxygen levels in the streams, prevent septic conditions from occurring, and reduce mineral concentrations, average annual supplemental flows of about 19.4 mgd in Bodcau Bayou and 8.2 mgd in Dugdemona Bayou would be needed by 1980.

(6) An existing project on Bodcau Bayou, Lake Erling above the Arkansas state line, supplies approximately 30 mgd of water supply to the International Paper Company plant at Springhill, Louisiana. A portion of the yield is used for pollution control in the stream.

i. Kiamichi River, Little River and Bois d'Arc Creek (Arkansas)

(1) Detailed studies of the southeastern Oklahoma-southwestern Arkansas area were made in connection with a prior report 27/ by the Public Health Service. Economic studies in

connection with this report indicated probability of location of paper mills in the vicinities of Hugo and Broken Bow, Oklahoma; and Hope and Ashdown, Arkansas. New plants by the Champion Paper Company and Nekoosa-Edwards Paper Company are presently under construction in the vicinities of Hope, and Ashdown, Arkansas, respectively.

(2) In anticipation of extensive development of the pulp and paper industry in this area, water quality control storage has been provided in the Kiamichi and Little River basins for protection of the existing high quality of the tributary rivers in this area. These projects are shown on plate XI-1 and are described in Appendix XV.

j. Pine Creek

Detailed studies were made of Pine Creek below Paris, Texas, in connection with a study of the Corps of Engineers' Pat Mayse Reservoir, currently under construction on Sanders Creek. 9/ Economic studies by the Paris Chamber of Commerce, Campbell Soup Company, and the Public Health Service indicate extensive expansion of the food and kindred processing industry in this area. Because of high residual BOD in treated wastes from this industry, supplemental flows of about 13.8 mgd would be needed prior to 1980 to maintain quality in the stream, based on 90 percent removal of BOD. An alternative method of pollution control has been recommended in the Public Health Service report. Under this method, the treated wastes would be transported by pipeline to the Red River where higher flows are available for adequate assimilation. For elimination of pollution problems at the source, treatment levels of about 97 percent removal of BOD would be needed.

k. Other Tributary Streams

(1) Throughout the basin there are many small cities and rural communities located in the headwaters of tributary streams which have potential localized pollution problems. A listing of cities and towns would include Atoka and Idabel, Oklahoma; Nashville and Hope Arkansas; Sherman, Gilmer, and Sulphur Springs, Texas; and Ruston, Louisiana. Effluents from these communities are discharged, after treatment, into streams which have intermittent or little base flow. In these areas, provision of reservoir storage for supplemental flows is not considered to be a feasible means of pollution abatement. For all communities located in the headwaters of streams, high efficiency of waste treatment plant operation will be needed. A minimum of secondary waste treatment with final sedimentation and, in most instances, chlorination of effluents will be needed for bacteriological control.

(2) In some areas, adequately treated and chlorinated municipal and industrial return flows from cities and smaller communities could be diverted for irrigation. Better utilization of

these return flows is needed for stream pollution control and to reduce irrigation water demands on ground water aquifers. In the agricultural areas of the basin, continued surveillance and enforcement action by the States will be needed to prevent stream pollution from insecticide spraying.

(3) Irrigation return flows are expected to increase significantly by the year 2030. However, since potential irrigation supplies from ground water and streamflow are generally of good quality and low in dissolved solids concentration, projected increases in mineral concentration in return flows are not expected to exceed the upper limits of the Public Health Service Drinking Water Standards or impede assigned use of the streams.

15. QUALITY EVALUATION - LOWER RED RIVER

a. General

Various measures are needed to control existing and potential salt pollution of the Red River for the protection and expansion of water uses within the basin. The affected uses would include municipal, industrial and agricultural water supply; recreation; and fish and wildlife propagation.

b. Prior Reports and Current Programs

(1) Arkansas-Red River Basins Water Quality Conservation Study. The Division of Water Supply and Pollution Control, Public Health Service (now Federal Water Pollution Control Administration) completed a basic study in 1964 on water quality and sources of natural and manmade salt pollution, and suggested corrective measures for the Arkansas-Red River basins. 8/ The study area included the Upper Red River basin.

(2) Survey Report on Arkansas-Red River Basin, Water Quality Control Study. The U. S. Army Engineer District, Tulsa, Corps of Engineers, has completed a survey report in 2 parts on water quality control in an area encompassing the upper basin. 16/ Subsequent to authorization of Part I of the project, 2 experimental salt emission control structures (Areas V and VIII) have been constructed and $1 million (of a total contingent appropriation of $46 million) has been appropriated for experimental projects in emission Areas I (Arkansas River basin) and VI (Elm Fork of the Upper Red River). The two experimental projects constructed (Areas V and VIII) have involved a principle of applying a hydrostatic backhead to suppress the brine flow from salt springs. The project at source VIII on the South Fork of the Wichita River (Upper Red River basin)

has been abandoned after proving unsatisfactory. The other project, located in the flood plain of the Prairie Dog Town Fork of the Red River at source V near Estelline, Texas, is currently in operation. Although flows from the spring have been suppressed, the future effectiveness of the control measure is unknown. In some areas brine discharges are carried long distances through underground solution channels and appear at the surface as seeps.

(3) Arkansas-Red River Basin Water Pollution Control Program. The Federal Water Pollution Control Administration has initiated in the Upper Red River basin an extensive stream monitoring and analysis program, in cooperation with the Geological Survey and other Federal and State agencies. Assistance has been provided by the Federal Water Pollution Control Administration to other agencies including personnel training and laboratory analysis service.

(4) State Programs

The following actions have been taken in recent years by the State agencies to study, correct and prevent salt pollution in the Red River basin:

(a) An extensive program on oil field operations to eliminate brine and oil pollution including:

1. Eliminating open brine and oil waste pits or sealing with impervious material.

2. Deep well injection of brines.

3. Plugging abandoned oil wells to prevent brine intrusion into fresh water aquifers, especially before water flooding operations.

4. Proper casing of operating wells.

5. Surveillance and enforcement action on overall operation.

(b) The effectiveness of this program is shown in the following tabulation and reduced chloride loadings on basin streams, though only a few have improved in quality sufficiently to be used for municipal and industrial water supply:

Oil Field Pollution Control Activities, 1960 - 1966 29/

State	Brine Storage Pits Eliminated	Reinjection and/or Disposal Wells	Enforcement Actions	Percent of Brine Reinjected
Oklahoma	2,476	3,500	30	95.0
Texas	20,500	705	47	98.0

c. Salt Pollution Control Measures

(1) The extensive studies of the salt problem in the Red River have shown that to substantially reduce the natural chloride load to the streams of the basin (the most crucial basin water problem) the following control measures, or their equivalent, should be provided:

Major Problem Area* In Upper Basin	Proposed Solution	Estimated Percent Chloride Load Reduction
Area VI - Elm Fork of the Red River	Subsurface collection system with off-channel evaporation pond	80
Area IX - North and Middle Pease Rivers	Subsurface collection system with off-channel evaporation pond	70
Area XIII and XIV - Jonah Creek and Salt Creek of Prairie Dog Town Fork of the Red River	Subsurface collection system with off-channel evaporation pond	70
Area XI - Prairie Dog Town Fork of the Red River	Subsurface collection system with off-channel evaporation pond	50
Area XV - Little Red River	Complete impoundment in an evaporation pond downstream from source area	90
Area VII, VIII, and X - North, Middle, and South Forks of the Wichita River	Low flow dams and off-channel evaporation pond	80

* Area designations in Ark-Red River Basins Water Quality Conservation Study (b(1))

Source: Corps of Engineers 16/

(2) The effectiveness of the control measures would be limited to some degree by the existing chlorides absorbed and deposited in the banks, beds, and floodplains of the streams.

(3) A detailed evaluation of the effectiveness of the control measures on reduction of sulfate concentrations in the streams has not been made to date. There will be some minor reduction, however, in areas where gypsum deposits are located upstream from the control structures. In most areas the gypsum deposits are interbedded with the salt formations.

d. Effects of the Navigation and Bank Stabilization Plan

(1) An interim study 30/ on the Red River Navigation and Bank Stabilization Plan was completed in December 1964. Results of this study indicated that the proposed bank stabilization would substantially reduce turbidity throughout the length of the main stem. The navigation improvements to the channel below Shreveport, Louisiana, would also effect a reduction in turbidity through reduced velocities. To some degree, the navigation pools would equalize the mineral quality variations. Maximum concentrations would be reduced and minimum concentrations would be increased, with a trend toward a weighted average. A more consistant mineral quality would result.

(2) The navigation features, however, would have some detrimental effect on the waste assimilation capacity of the Red River in the slack water areas between the proposed locks and dams. The detriment would occur through decreased velocities, higher temperatures, and deposition of sediment, which would include organic material in the deeper portions of the channel. Projected waste flows in the Shreveport area would approximate 64 mgd in 1980 and increase to about 200 mgd by 2030. Based on projected low flows in the Red River of about 1400 mgd during the critical period, as shown on plate XI-7, the estimated dilution ratio for waste flow would range from 21:1 in 1980 to 7:1 in 2030.

e. Effects of Plans on Mineral Quality

(1) A study has been made of the projected effects on quality of the main stem of the Red River from Denison Dam to Shreveport, Louisiana, resulting from proposed basin development. The analysis of projected water quality was based on the following conditions:

(a) All existing and authorized projects in place.

(b) Full development of the projects in the proposed Texas Water Plan. 31/

(c) All proposed projects in the Lower Red River comprehensive study in place.

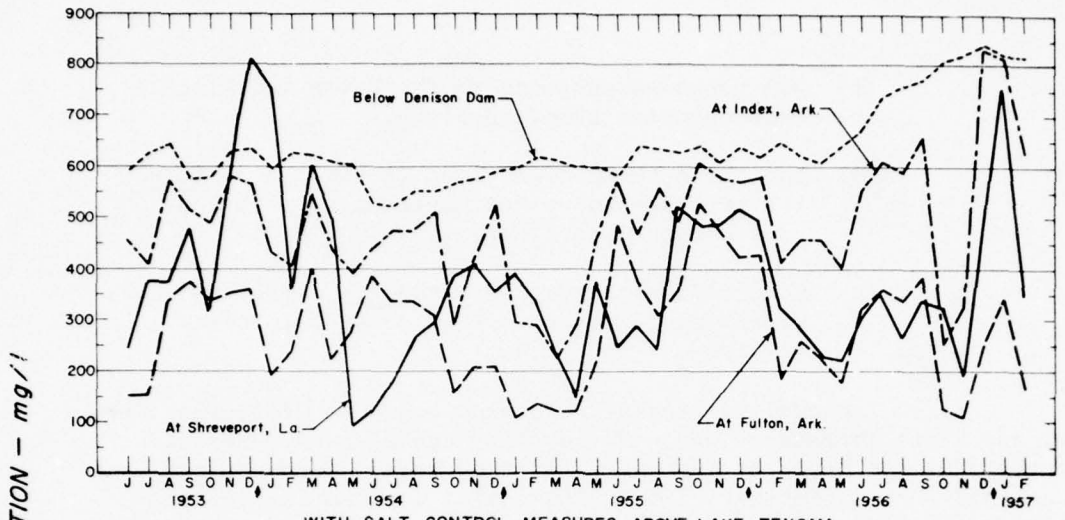
(d) The above three conditions (1 through 3) with the proposed Upper Red River basin salt control measures in place.

(e) Conditions 1 through 3 without the proposed Upper Red River basin salt control measures in place.

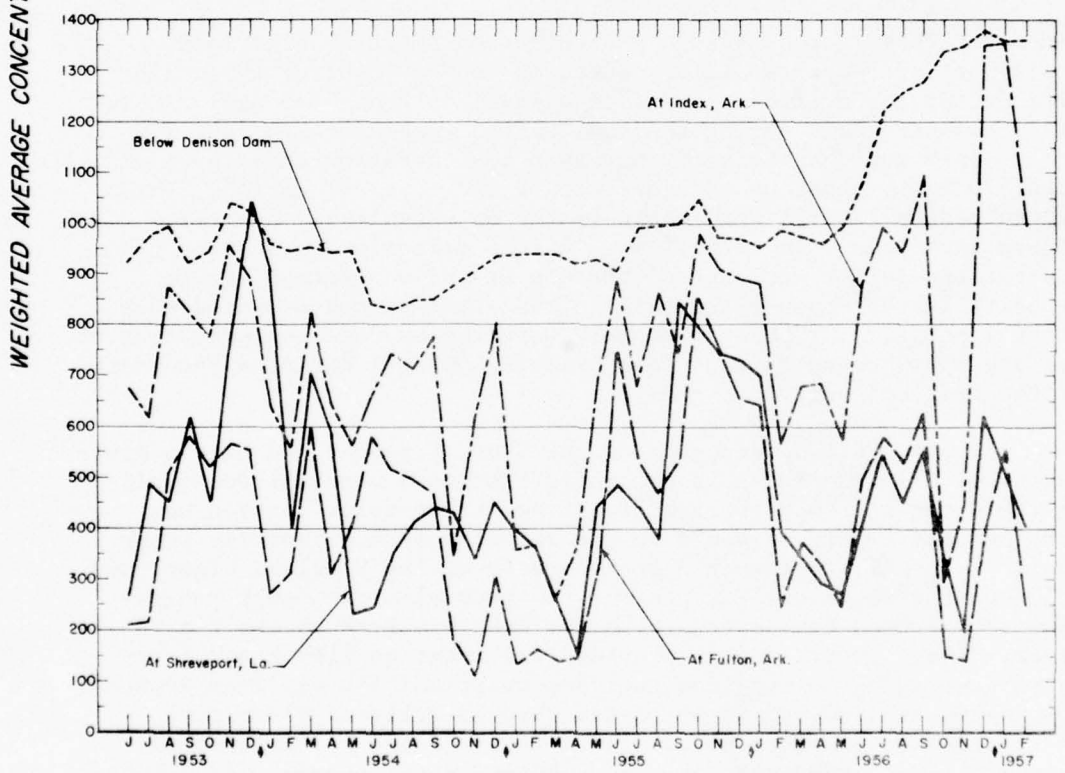
(2) The quality studies were also based on Geological Survey and State streamflow and water quality records and reservoir routings by the Corps of Engineers for the critical drought period, June 1953 through February 1957. Results of analyses are graphically presented on plates XI-10 through XI-15.

(3) With upper basin salt control measures in place, the mean monthly weighted average concentration of total dissolved solids at Shreveport would be decreased from a level of about 510 mg/l during the critical period to a level of about 370 mg/l. Chloride concentrations during the same period were approximately 150 mg/l. They would be reduced from this concentration to a level of about 70 mg/l, based on a recurrence of the critical period. This concentration is well within the limits of established Louisiana stream standards. An overall significant reduction in sulfate concentrations is not anticipated because of the widespread gypsum deposits in the upper basin outside the areas of the proposed salt control projects. The mean monthly weighted average concentration of sulfates at Shreveport would approximate 100 mg/l during a recurrence of the critical period.

(4) Full development of the Blue, Kiamichi and Little River basins of Oklahoma and Arkansas would produce a more uniform quality of the water in the main stem of the Red River below Denison Dam. Particularly important would be the releases from authorized water quality control storage in Hugo Reservoir on the Kiamichi River, and releases for water quality control and hydroelectric power generation from Broken Bow Reservoir on the Mountain Fork of the Little River. The authorized plan provides for water quality control releases averaging 90 mgd from Hugo Reservoir and 110 mgd from Broken Bow Reservoir (100 mgd to be passed through Millwood Reservoir). These releases of water would alleviate projected pollution from pulp and paper industries on the tributary streams and would dilute high chloride concentrations in the main stem until such time as the water is needed for municipal and industrial purposes, and the upper basin salt control measures are in place. Under the planned operating schedule peaking power releases for hydroelectric power



WITH SALT CONTROL MEASURES ABOVE LAKE TEXOMA



WITHOUT SALT CONTROL MEASURES ABOVE LAKE TEXOMA

WEIGHTED AVERAGE CONCENTRATION — mg/l

COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS

PROJECTED MINERAL QUALITY–MAIN STEM

TOTAL DISSOLVED SOLIDS CONCENTRATION

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration

JUNE 1968

PLATE XI-10

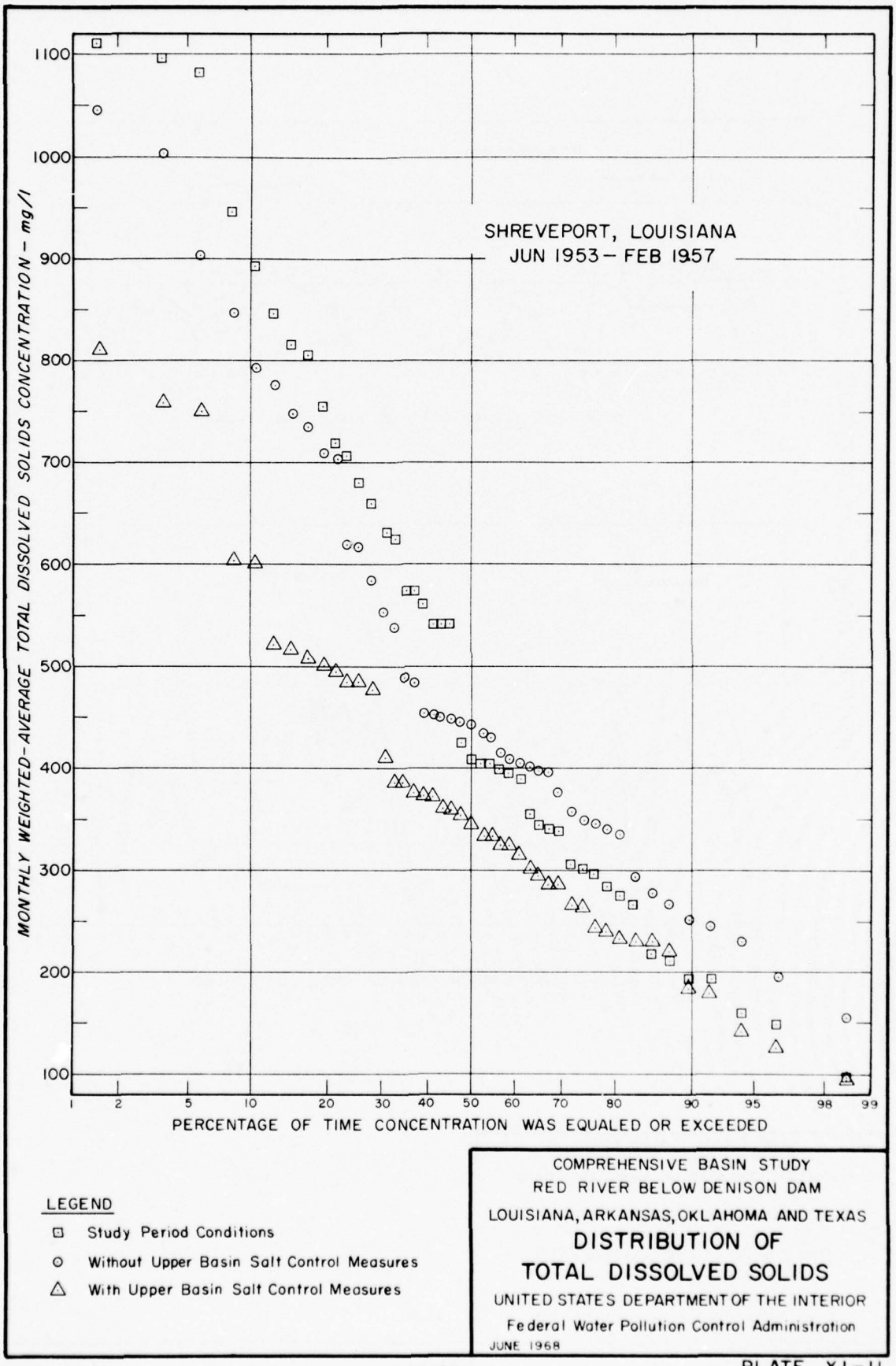
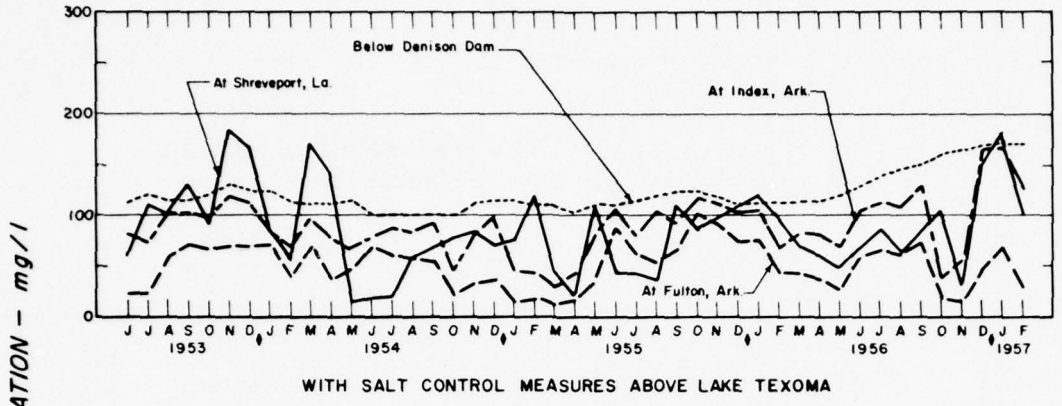
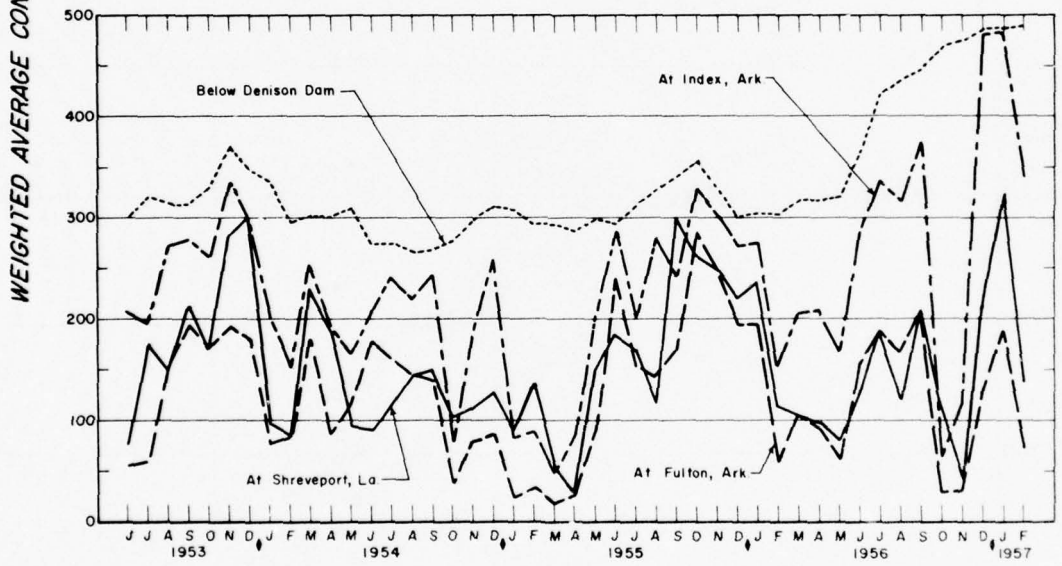

SHREVEPORT, LOUISIANA
JUN 1953 – FEB 1957
MONTHLY WEIGHTED-AVERAGE TOTAL DISSOLVED SOLIDS CONCENTRATION - mg/l
1100
1000
900
800
700
600
500
400
300
200
100
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
PERCENTAGE OF TIME CONCENTRATION WAS EQUALED OR EXCEEDED
LEGEND
Study Period Conditions
Without Upper Basin Salt Control Measures
With Upper Basin Salt Control Measures
COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS
DISTRIBUTION OF
TOTAL DISSOLVED SOLIDS
UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
JUNE 1968

PLATE XI-11



WITH SALT CONTROL MEASURES ABOVE LAKE TEXOMA



WITHOUT SALT CONTROL MEASURES ABOVE LAKE TEXOMA

WEIGHTED AVERAGE CONCENTRATION - mg/l

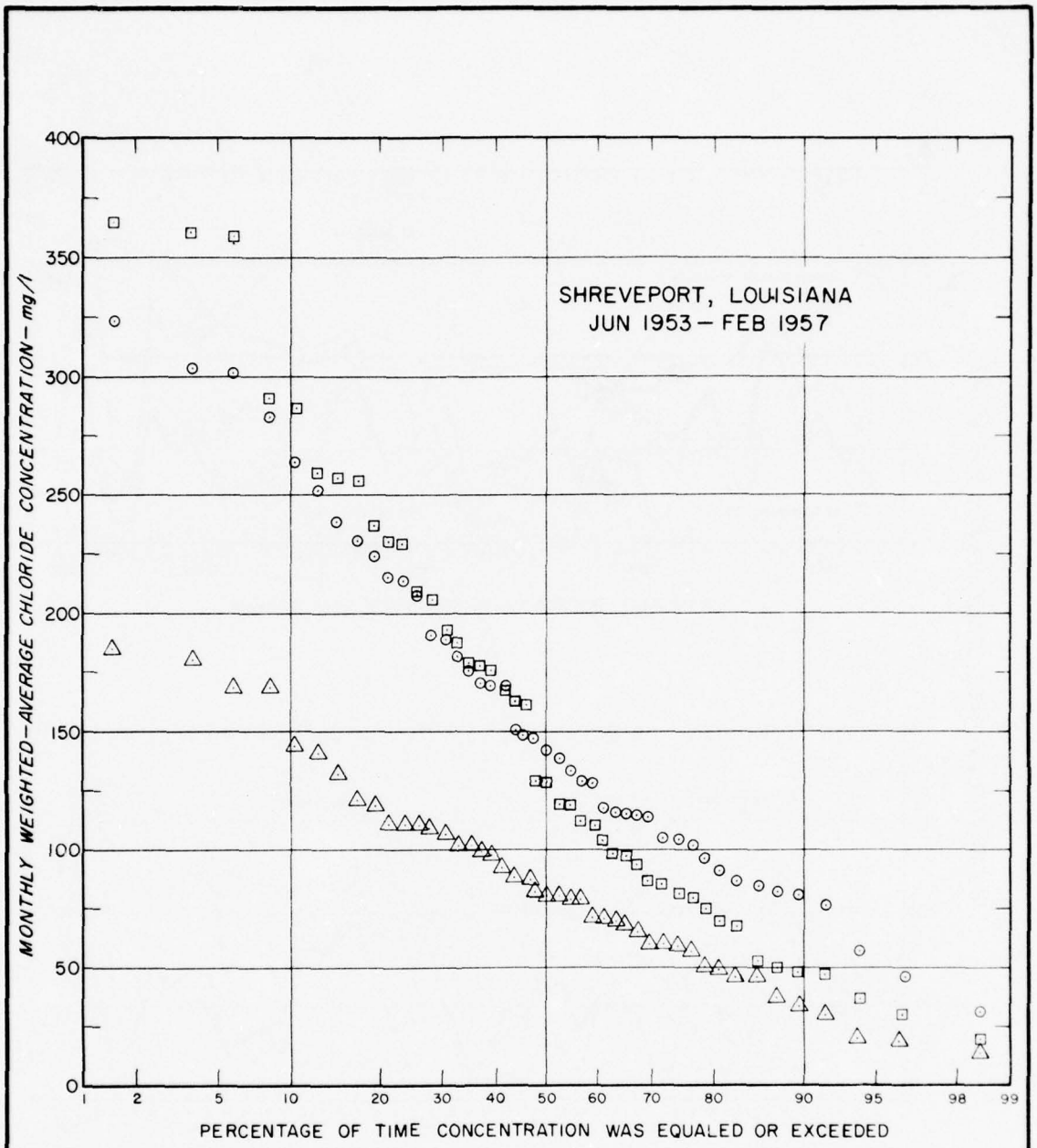
COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS

PROJECTED MINERAL QUALITY—MAIN STEM

CHLORIDE CONCENTRATION

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
JUNE 1968

PLATE XI-12



LEGEND

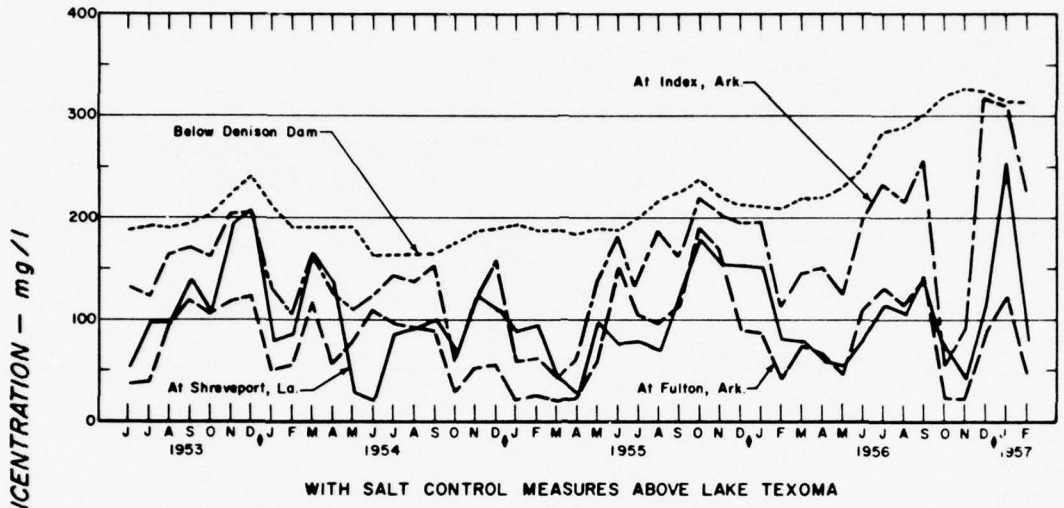
- ⊡ Study Period Conditions
- ⊙ Without Upper Basin Salt Control Measures
- △ With Upper Basin Salt Control Measures

COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS

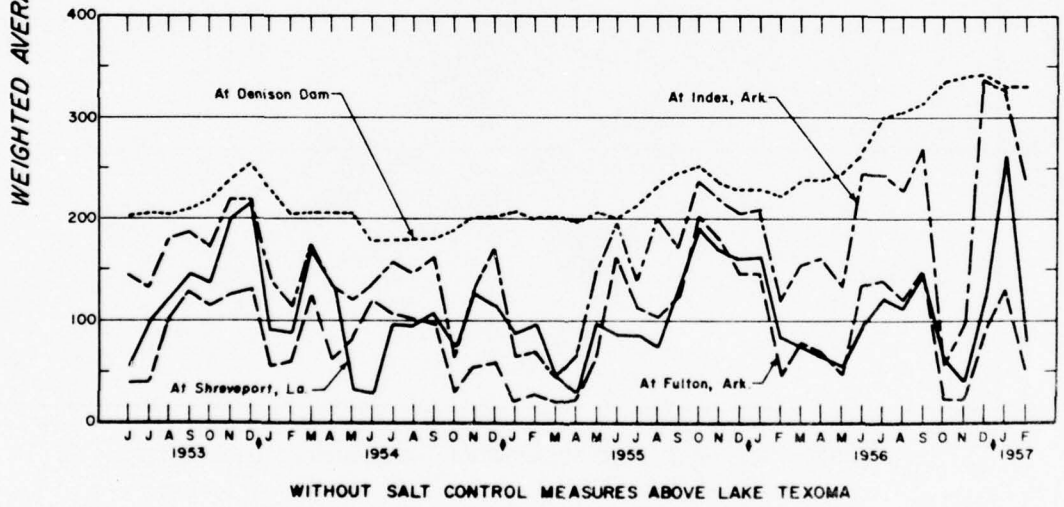
DISTRIBUTION OF CHLORIDE

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
JUNE 1968

PLATE XI-13



WITH SALT CONTROL MEASURES ABOVE LAKE TEXOMA



WITHOUT SALT CONTROL MEASURES ABOVE LAKE TEXOMA

WEIGHTED AVERAGE CONCENTRATION — mg/l

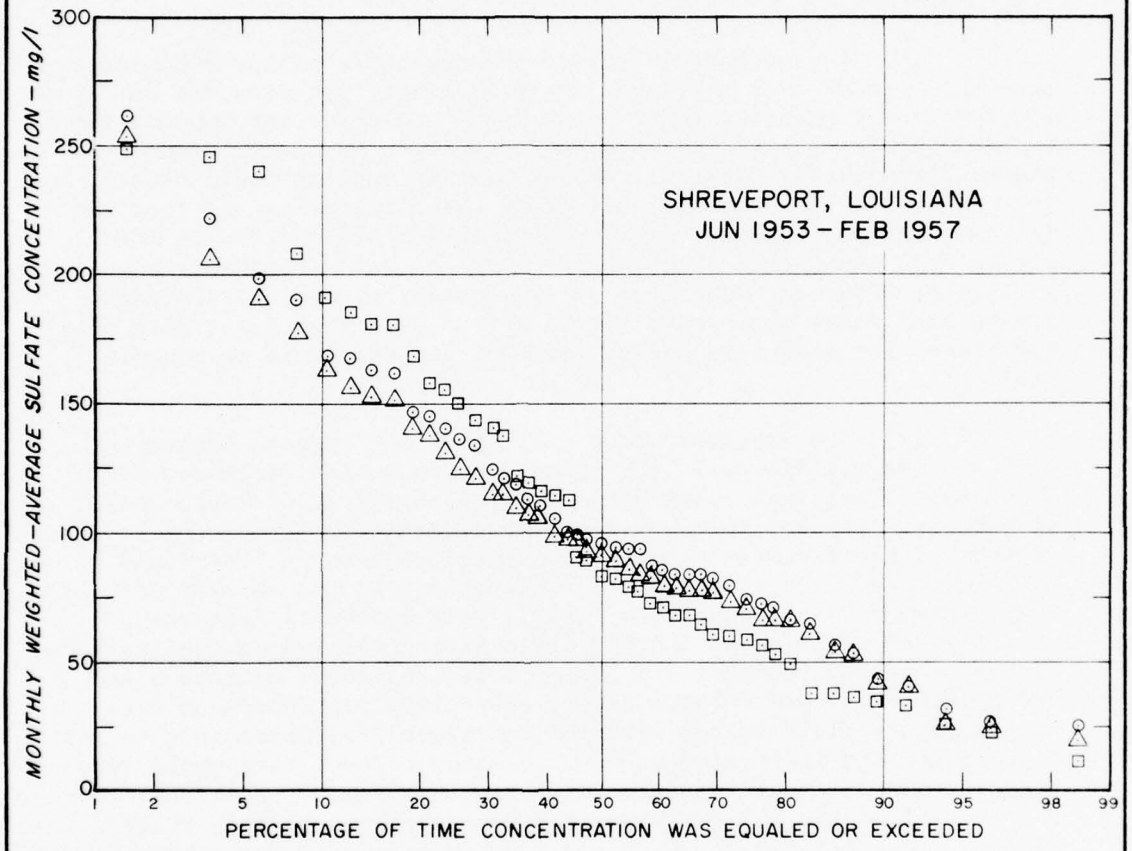
COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS

PROJECTED MINERAL QUALITY — MAIN STEM

SULFATE CONCENTRATION

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
JUNE 1968

PLATE XI-14



LEGEND

- ⊡ Study Period Conditions
- ⊙ Without Upper Basin Salt Control Measures
- △ With Upper Basin Salt Control Measures

COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS

DISTRIBUTION OF SULFATE

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
JUNE 1968

PLATE XI-15

generation from Broken Bow Reservoir would also alleviate potential pollution problems on the Mountain Fork and the Little River below the project during the period of operation, and would have a major effect on reduction of mineral concentrations in the main stem of the Red River. During the critical period (June 1953 through February 1957) releases through Millwood Reservoir would average 2,330 mgd (3,612 cfs).

(5) The proposed diversion by the State of Texas of water from the main stem of the Red River near Index, Arkansas, as reflected in the proposed Texas Water Plan, would further improve the mineral quality in the Red River below Fulton, Arkansas. (See plates XI-10 through XI-15.) Improvement in quality would result from diversion of about 550 mgd during the critical period from the Red River having a higher salt content than major inflows to the stream from the Little River basin. The planned diversions range as high as 2790 mgd, depending on flow in the river. Diversions during high flows would have little effect on stream quality in the Red River, but diversion during low flow periods would be beneficial.

(6) The improved water quality of the stream, however, would be largely offset in the reach between Fulton, Arkansas and Shreveport, Louisiana, with projected industrial development and without salt control measures above Lake Texoma. Degradation to quality of the river in this reach during low flow periods would result from projected pulp and paper operations in the vicinity of Hope, Arkansas, and Texarkana, Texas. With effluents from these mills, water would enter the Red River having chloride concentrations of approximately 700 mg/l and 250 mg/l at the mouths of Bois d'Arc Creek (Arkansas) and Sulphur River, respectively. Continued discharge of oil field brines into the Red River from operations in the Black Bayou and Twelvemile Bayou watersheds of Louisiana would further degrade the quality of the river in this reach. With full development of the Sulphur River and Cypress Creek basins, there would be very limited flows to the Red River from these tributary streams to dilute the chloride loadings.

(7) Even with the projected industrial deveopment in this area and without control of the upper basin salt sources, some improvement in mineral quality of the Red River at Shreveport would result from the dilution and equalizing effect of the hydroelectric power releases from the Little River system. Maximum dissolved solids concentration would be reduced slightly over conditions existing during the critical period. At Shreveport, the mean monthly weighted-average concentration of total dissolved solids would be decreased from a level of about 510 mg/l to a level of about 490 mg/l for the critical period. Chloride concentrations would remain

at an average level of about 150 mg/l in the critical period. As shown on plate XI-13, without salt control measures above Lake Texoma, the monthly weighted-average concentration of chlorides could be expected to exceed 250 mg/l about 12 percent of the time during a similar critical period.

(8) Since the salt problem in the Lower Red River originates principally in the area above Denison Dam, consideration should be given to improvement in quality of waters of the main stem by some means until salt control measures are effective. A possible solution would be to consider a system management program of basin reservoirs, including the hydroelectric power projects. Quantity and quality of water could be equated to maintain optimum conditions for all useful purposes of the stream. This could entail some reallocation of reservoir storages and costs due to benefit changes.

(9) Quality problems projected for the reach of the main stem between Fulton,Arkansas, and Shreveport could be minimized with adequate control measures. To minimize or avoid problems of color and high concentrations of mineral constituents, releases of process water and other wastes should be made during periods of high flow in the receiving streams.

(10) Projected quality of the Red River would be better than reflected in the analysis more than 95 percent of the time. The analysis was made on the basis of recurrence of the most critical drought on record. However, selective withdrawal and off-channel storage are the keys to a continuous supply of good water to cities and industries whose source of supply is the Red River. The off-channel reservoirs near the point of use would be needed to enable the quantity and quality of water to be equated over a period of time.

16. WATER SUPPLY PLAN

a. General

Prior to 1980, storage will be needed for water supply purposes in 25 additional Federal reservoirs, 8 Corps of Engineers reservoirs, including one enlargement, and 17 Soil Conservation Service projects, as listed in tables 19 and 20. Sufficient storage will be needed in Federal projects to provide dependable yields of about 200 mgd by 1980, in addition to existing supplies, to supply basin needs.

b. Corps of Engineers' Projects

A listing of the water supply projects proposed for construction by the Corps of Engineers to meet existing needs or those expected to develop within the next 10 to 15 years is shown in table 19.

c. Soil Conservation Service Projects

There are 17 Soil Conservation Service watershed projects proposed for construction in the 10-15 year plan to provide municipal supply for 13 small cities and rural communities throughout the basin. The projects would provide approximately 55.9 mgd of yield for the communities of Sherman, Bells, Howe, Deport, and Bonham, Texas; Atoka, Allen, and Antlers, Oklahoma; Magnolia, Arkansas; and Ringgold,Gibsland, Alexandria and Bossier City, Louisiana. In addition, two additional reservoir projects are proposed for supply of 5 mgd of water supply for the city of Durant, Oklahoma. These projects would be an alternative to initial water supply storage in the Corps of Engineers proposed Durant Reservoir. Detailed data on the proposed projects is presented in Appendixes V and XV.

d. Summary

A summary of projected municipal and industrial water supply needs and the proposed sources of supply are presented in table 21. With construction of reservoir projects as proposed in this report and with proper utilization of ground water and return flows, sufficient water resources would be available to meet all foreseeable municipal and industrial water supply needs of the basin to the year 2080.

Table 19

Proposed Corps of Engineers Projects
for Municipal and Industrial Water Supply
10 to 15 Year Plan

Reservoir	Stream	Estimated Yield for M&I (mgd)	M&I Water Supply
Albany	Island Bayou, Oklahoma	32	Out-of-basin diversion
Durant	Blue River, Oklahoma	30	City of Durant
Parker	Muddy Boggy Ck., Oklahoma	47	City of Ada (Out-of-basin)
Bonham	Bois d'Arc Ck., Texas	24	Cities of Denison and Sherman
Liberty Hill	Mud Creek, Tex.	30	City of New Boston and Anglo-Southern Paper Corp.
Bayou Dorcheat	Bayou Dorcheat, Arkansas	44*	Columbia Co., Ark. and Webster Parish, La.
Kisatchie	Kisatchie Bayou, Louisiana	52**	City of Natchitoches and pulp & paper industry
Titus County	Cypress Creek, Texas	72***	City of Mt. Pleasant & Out-of-basin diversion
Caddo Enlargement	Cypress Creek, Texas-La.	107	Cities of Shreveport La. & Marshall, Texas
McGee Creek	McGee Creek, Oklahoma	60	City of Oklahoma City (Out-of-basin)
		498	

Detailed data on the above projects is presented in Appendix XV, Plan Formulation.

* Total yield 80 mgd. Project includes storage for water quality control.

** Total yield 86 mgd. Project includes storage for irrigation water supply.

*** Net yield. The gross yield is 107 mgd.

Table 20

Proposed Soil Conservation Service Projects
for Municipal and Industrial Water Supply
10 to 15 Year Plan

Watershed	Stream	Estimated Yield for M & I (mgd)	M & I Water Supply
3-19 (5 Res.)	Choctaw Creek, Tex.	4.0	Sherman, Bells, & Howe, Texas
3-25a	Bois d'Arc Ck., Tex.	6.2	Bonham, Texas
*3-23(2 Res.)	Little Blue River, Okla.	(5.0)	Durant, Okla.
3h2-4	Boggy Ck., Okla.	1.0	Atoka, Okla.
3h2-6	Boggy Ck., Okla.	1.0	Allen, Okla.
3i-4	Dumpling-Beaver Cks., Okla.	2.8	Antlers, Okla.
3m1-7	Big Ck., Ark.	8.9	Magnolia, Ark.
3m2-3(2 Res.)	Cypress-Black Bayous, La.	5.0	Bossier City, La.
3k-11	Mustang Ck.-Deport Ck, Tex.	0.2	Deport, Texas
3o1-3	Tucker Ck.-Black Lake Bayou, La.	1.9	Ringgold, La.
3o1-4	Baker Ck.-Black Lake Bayou, La.	1.9	Gibsland, La.
3-68	Bill Bayou.-Bayou Jean de Jean, La.	13.0	Alexandria, La.
10-17	Brown Ck.-Bayou Rapides, La.	10.0	Alexandria, La.
	Total	55.9	

* Alternative project to initial water supply storage for Durant, Oklahoma, in the Corps of Engineers proposed Durant Reservoir.

Table 21

Water Supply Allocations - Municipal and Industrial Demands
(mgd)

Area	Municipal and Industrial Water Requirements 1980	2030	2080	Supply	Yield
1	6.6	66.8	123.1	Existing and Authorized	
				Boswell (ult)*	555.0
				Hugo Reservoir (ult)*	191.0
				Atoka Reservoir*	47.0
				Tuskahoma Reservoir*	200.0
				Clayton Reservoir*	140.0
				Wells and Springs	9.4
				Proposed	
				SCS Boggy Creek (3h2-4,6)	2.0
				SCS Dumpling-Beaver Creeks (3i-4)	2.8
				Parker Reservoir*	47.0
				McGee Creek Reservoir*	60.0
				Subtotal	1,254.2
2	80.1	129.5	133.2	Existing and Authorized	
				Lukfata Reservoir*	60.0
				Pine Creek Reservoir*	120.0
				Millwood Reservoir*	265.0
				Dierks Reservoir	19.0
				Broken Bow Reservoir	65.0
				DeQueen Reservoir	32.0
				Gillham Reservoir	60.0
				Wells, springs & small lakes	4.8
				Subtotal	625.8
3	38.6	77.8	145.4	Existing and Authorized	
				Pat Mayse Reservoir	55.0
				Wells, springs & small lakes	29.8
				Proposed	
				SCS Mustang Creek (3k-11)	0.2
				SCS Choctaw Creek (3-19) (5 Res.)	4.0
				SCS Lower Blue R. (3-23) (2 Res.) **	5.0
				SCS Bois d'Arc Creek (3-25a)	6.2
				Durnat Reservoir (ult.)	85.0
				Bonham Reservoir	24.0
				Albany Reservoir*	32.0
				Subtotal	241.2
4	97.0	161.9	247.2	Existing and Authorized	
				Texarkana Reservoir	13.0
				Cooper Reservoir*	105.8
				Big Pine Reservoir	26.0
				Sabine River Basin	6.0
				Wells and small lakes	16.0
				Enlarged Texarkana Reservoir	143.0
				Proposed	
				Liberty Hill Reservoir	30.0
				Subtotal	339.8
5	79.5	192.6	289.8	Existing and Authorized	
				Ferrell's Bridge Reservoir	151.0
				Caddo Lake	(8.0)***
				Sabine River Basin	54.3
				Wells and small lakes	13.4
				Proposed	
				Titus County Reservoir (Net)	72.0
				Subtotal	290.7
6	182.2	437.5	773.9	Existing and Authorized	
				Lake Erling	30.0
				Cross Lake	54.0
				Red River	467.6
				Ground Water	37.4
				Proposed	
				SCS Big Creek (3ml-7)	8.9
				SCS Cypress-Black Bayou (3m2-3) (2 Res.)	5.0
				Enlarged Caddo Lake	107.0
				Bayou Dorcheat Reservoir	44.0
				Subtotal	753.9
7	33.8	53.5	89.8	Existing and Authorized	
				Sibley Reservoir	13.0
				Ground Water	6.1
				Proposed	
				SCS Black Lake Bayou Laterals (3ol-3)	1.9
				SCS Upper Black Lake Bayou (3ol-4)	1.9
				Kisatchie Reservoir	52.0
				Ground Water Development	14.9
				Subtotal	89.8
8	98.0	146.3	242.0	Existing and Authorized	
				Ground Water	52.3
				Proposed	
				SCS Bayou Jean de Jean (3-68)	13.0
				SCS Bayou Rapides (10-17)	10.0
				Red River	140.7
				Ground Water Development	26.0
				Subtotal	242.0
TOTAL	615.8	1,265.9	2,044.4		3,837.4

* Excess yield above projected needs for out-of-basin diversion.
** Alternative project to initial water supply storage for Durant, Oklahoma, in the Corps of Engineers proposed Durant Reservoir.
*** No existing storage allocated to water supply.

17. WATER QUALITY CONTROL PLAN

The proposed plan of improvement provides for construction of 3 reservoir projects with storage reserved for water quality control. There projects are as follows:

Reservoir	Stream	Nearest City	Estimated Yield for Quality Control (mgd)
Corps of Engineers:			
Bayou Dorcheat	Bayou Dorcheat, Ark.	Magnolia	16.0
	Bodcau Bayou, La.	Springhill	19.5
Soil Conservation Service:			
Ws. 3-23	Little Blue River, Okla.	Durant	1.4
Ws. 3m1-7	Big Creek, Ark.	Magnolia	3.8
		Total	40.7

Detailed data on the proposed projects are presented in Appendixes V and XV. The projects will provide for the projected 2080 needs in their respective watersheds (except Big Creek).

a. Bayous Dorcheat and Bodcau (Including Big Creek)

(1) The plan for pollution abatement in Big Creek and Bayou Dorcheat below Magnolia, Arkansas, upstream from the Louisiana state line, is a joint plan of the Corps of Engineers and the Soil Conservation Service. Storage would be provided by the Soil Conservation Service in the Big Creek watershed to supply the initial needs in the two streams to approximately the year 2000. At approximately this time, projected treated waste discharges from the Magnolia area are expected to exceed the assimilative capacity of the stream and the available flows from the upstream watershed. It will then be necessary for a portion of the treated wastes to be transported by pipeline directly to Bayou Dorcheat where additional streamflow and reservoir releases from the Dorcheat Reservoir would be available for assimilation. In addition, sufficient storage has been included in the Dorcheat Reservoir to supply the projected water quality control needs (BOD and minerals) in the adjoining Bodcau Bayou watershed.

(2) The dependable yield of the proposed projects would meet the projected water supply and water quality control needs of the area to about the year 2060. Prior to construction of additional projects to meet projected water supply needs beyond this period, a restudy of the stream quality and use objectives should be made. Advancements in technology of waste treatment and subsequent reduction in cost of such measures could reduce the projected need for and value of the assigned storage for water quality control purposes.

b. Mineral Bayou

Water quality storage in the Soil Conservation Service Reservoir on Mineral Bayou (Little Blue River) for low flow augmentation can provide the supplemental flow needed for stream assimilation of the waste effluent from the city of Durant, Oklahoma.

c. Other Pollution Control Measures

(1) The projected water quality need expected to develop on Cypress Creek as a result of the waste discharges from the Mt. Pleasant-Pittsburg, Texas area would be satisfied by the planned release of 35 mgd from Titus County Reservoir to maintain the existing water supply yield of the downstream Ferrells Bridge Reservoir (Lake O' The Pines). The water quality control need is expected to occur between the two reservoir projects. Under this plan, no water quality control storage would be needed in the proposed Titus County Reservoir.

(2) Through recent agreements between the state of Texas and interested Federal agencies, the following measures would be taken by the state to assure compliance with established stream standards of Texas and Arkansas for the interstate stream, Sulphur River below Texarkana Reservoir:

(a) Treatment of municipal and paper mill wastes to the degree necessary for BOD control.

(b) Requirement that the proposed pulp and paper industry purchase sufficient reservoir storage or yield to maintain a minimum flow in the stream of 10 cfs (6.5 mgd) plus twice the projected waste discharge from the mill. This storage would be used for industrial water supply and, as required to maintain stream standards, for water quality control in the receiving stream.

(3) In addition to reservoir releases from Texarkana Reservoir, the Corps of Engineers is providing low flow releases of 3.2 mgd from Ferrells Bridge Reservoir (Lake O' The Pines) and will provide from the Cooper Reservoir, on its completion, a low flow release of 3.2 mgd.

CHAPTER VI- BENEFITS

18. WATER SUPPLY STORAGE BENEFITS

a. General

(1) The benefits for municipal and industrial water supply storage in Federal reservoirs result from improvements in quantity, dependability, quality, and physical convenience of water use. In addition, reservoirs create aesthetic recreation areas for swimming, fishing, boating, camping, and water skiing accessible to those living in and near the study area. The sale of goods and services associated with these facilities usually becomes a significant segment of the economy of the area. Property values in the vicinity of the developments are generally improved. Public health is benefited through a dependable water supply which has more uniform physical and chemical quality characteristics.

(2) Senate Document No. 97 (87th Congress, 2nd session) makes the following statement concerning evaluation of these benefits:

> "The amount water users should be willing to pay for such improvements in lieu of foregoing them affords an appropriate measure of this value. In practice, however, the measure of the benefit will be approximated by the cost of achieving the same results by the most likely alternative means that would be utilized in the absence of the project."

b. Alternative

Water supply projects, as described in chapter V, are proposed for development in areas which have deficient ground water reserves to meet future needs. Therefore, further ground water development in the project areas would not be a reasonable alternative to the proposed projects. Single-purpose water supply reservoirs were determined to be the most reasonable alternatives to water supply storage in the proposed Corps of Engineers multiple-purpose reservoir projects, except for Kisatchie Reservoir. In this instance, the selected alternative was treatment of water from the Red River. Dual-purpose flood detention-water supply reservoir projects were determined to be the least costly alternatives to water supply storage in the multiple-purpose Soil Conservation Service reservoirs.

c. Value of Benefits

The cost of a single-purpose (or least-costly alternative) water supply project was used as a measure of benefits for conservation storage in the multiple-purpose project. In evaluating the cost of a water supply reservoir, the capital cost was converted to an equivalent annual cost. The project costs were amortized over a 100-year period, the estimated project life, at an interest rate of 3¼ percent. Estimated operation and maintenance costs were added to annual charges for interest and amortization. A summary of the value of benefits attributable to storage in the Federal projects for municipal and industrial water supply is given in table 22.

19. WATER QUALITY CONTROL STORAGE BEENFITS

a. General

Water quality as a project purpose was considered to be economically justified as a "last added" increment in the formulation of plans for multiple-purpose water resource development. Improved water quality resulting from reservoir releases for other purposes was not utilized as justification for separable water quality control storage in proposed projects. For example, reservoir releases from existing hydroelectric power projects in the basin enhance quality of the streams during operation periods. Benefits can be attributed to the projects for low flow augmentation and more uniform flow in the Lower Red River and major tributaries on which projects are located. Benefits also accrue to these projects for low flow augmentation of the lower Mississippi River during low flow periods on that stream.

b. Use Benefited

For the proposed projects, benefits attributable to improved water quality conditions were assessed to the water-use purpose actually being benefited. Benefits would accrue to fish and wildlife, recreation and aesthetics. Higher dissolved oxygen levels in the streams would be maintained, which are essential for the propagation of fish and wildlife. Reservoir releases during summer months, when water quality control needs are generally most critical, would maintain sufficient flow in the streams of acceptable quality to permit higher quality species of game fish to live in the area. The releases would protect and enhance use of the streams and the headwaters of downstream reservoirs for sport fishing. Outdoor recreation benefits from flow regulation would accrue through increased utilization of the water, increased use of shoreline and reservoir headwaters, and increased value of each recreation experience. These benefits may be directly attributed to improvement in quantity of flow required for such water sports as fishing and boating,

Table 22

Water Supply Benefits

Reservoir	Construction Cost [1]	Annual Amortization Cost [2]	Annual Operation and Maintenance Cost [3]	Total Annual Cost
Corps of Engineers (Summary of single-purpose water supply projects costs.)				
Albany	$ 6,690,000	$226,700	$ 35,300	$262,000
Parker	5,920,000	200,600	44,400	245,000
Durant	6,250,000	211,800	63,600	275,400
Bonham	10,087,000 [4]	341,800	36,900	378,700
Liberty Hill	9,300,000	315,100	46,100	361,200
Kisatchie [5]	--	--	--	332,000
Bayou Dorcheat	12,081,000	413,000	86,000	499,000
Titus County	22,647,000	767,000	104,000	871,000
Caddo Enlargement	8,113,000	333,000	6,300	339,300
McGee Creek	9,160,000	314,000	44,000	358,000

Soil Conservation Service

Watershed	City	Benefits [6]	Watershed	City	Benefits [6]
3-19(5 Res.)	Sherman, Bells, and Howe, Texas	$67,920	3m1-7	Magnolia, Arkansas	101,600
3-25a	Bonham, Texas	19,400	3m2-3(2 Res.)	Bossier City, Louisiana	35,200
3-23(2 Res.)	Durant, Oklahoma [7]	57,480	3k-11	Deport, Texas	5,000
3h2-4	Atoka, Oklahoma	6,750	3o1-3	Ringgold, Louisiana	9,140
3h2-6	Allen, Oklahoma	6,780	3o1-4	Gibsland, Louisiana	10,060
3i-4	Antlers, Oklahoma	33,340	3-68	Alexandria, Louisiana	62,030
			10-17	Alexandria, Louisiana	38,700

1/ Costs furnished by the Corps of Engineers.
2/ Based on 3½ percent interest rate and 100-year period of amortization.
3/ Includes major replacements.
4/ Includes interest during construction.
5/ Based on treating Red River water.
6/ Computed by the Soil Conservation Service by least-costly alternative method.
7/ Alternative project to initial water supply storage for Durant, Oklahoma, in the Corps of Engineers proposed Durant Reservoir.

improvement in water quality required for such water contact sports as swimming, and general enhancement of the total environment.

c. Alternative Cost

In studies to determine the need for and value of storage in Federal reservoir projects for water quality control, alternative pollution control methods were considered. These included single-purpose (or least-costly alternative) reservoirs, advanced waste treatment, deep well injection of wastes, pipelines to larger receiving streams, and diversion of treated wastes for irrigation.

d. Value of Benefits - Alternative Cost Method

Benefits for the proposed projects have been evaluated on the basis of the least-costly alternative means for maintaining acceptable water quality in the receiving streams, in lieu of water quality control storage in the multiple-purpose reservoirs. The annual values of storage for water quality control are presented in the following tabulation:

Reservoir Project	Stream	Benefits ($)
Corps of Engineers:		
Bayou Dorcheat	Bayou Dorcheat, Ark-La. and Bodcau Bayou, La.	509,000
Soil Conservation Service:		
W'shed. 3 ml-7	Big Creek, Ark. and Bayou Dorcheat, Ark-La.	26,200 1/
W'shed. 3-23	Mineral Bayou, Okla.	10,000

1/ By the joint CE-SCS plan, initial needs in Bayou Dorcheat to be supplied by storage in the SCS project.

e. Value of Benefits - Use Method

Benefits for water quality control storage in the three multiple-purpose reservoirs have also been evaluated by the Use Method and computed on the basis of greatest benefit to an individual use. Benefits for fish and wildlife were evaluated by the Bureau of Sport Fisheries and Wildlife, and recreation benefits were evaluated by the Bureau of Outdoor Recreation, in coordination with the Federal Water Pollution Control Administration. No tangible benefit was

assigned to aesthetics. The annual values of storage for water quality control, based on the greatest benefit to an individual use, are presented in the following tabulation:

Reservoir Project	Stream	Benefits ($) Fish and Wildlife	Recreation	Total
Corps of Engineers:				
Bayou Dorcheat	Bayou Dorcheat, Ark-La.	13,000 1/	147,000 1/	160,000 1/
	Bodcau Bayou, La.	4,000	103,000	107,000
	Total	17,000	250,000	267,000
Soil Conservation Service:				
W'shed. 3m1-7	Big Creek, Ark.	500	15,000	15,500
	Bayou Dorcheat, Ark-La.	13,000 1/	147,000 1/	160,000 1/
	Total	13,500	162,000	175,500
W'shed. 3-23	Mineral Bayou, Okla.	800	400	1,200

1/ By the joint CE-SCS plan, initial needs in Bayou Dorcheat to be supplied by storage in the SCS project.

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BASIN BOUNDARY
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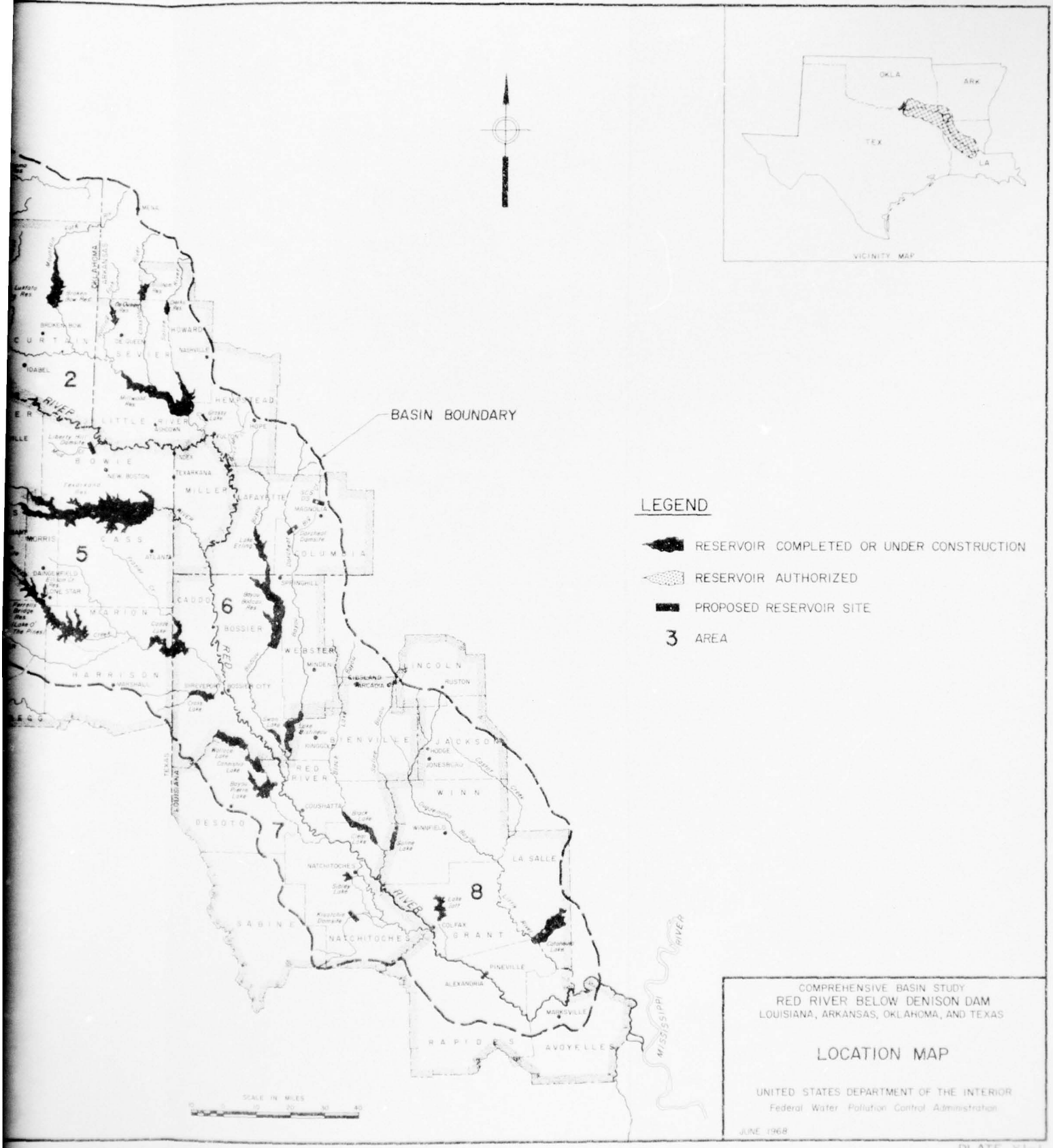
RED RIVER
SCALE IN MILES



COMPREHENSIVE BASIN STUDY
RED RIVER BELOW DENISON DAM
LOUISIANA, ARKANSAS, OKLAHOMA, AND TEXAS

LOCATION MAP

UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration

JUNE 1968

PLATE XI-1

AD-A036 753 RED RIVER BASIN COORDINATING COMMITTEE NEW ORLEANS LA F/G 8/6
COMPREHENSIVE BASIN STUDY. RED RIVER BELOW DENISON DAM, ARKANSA--ETC(U)
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RED RIVER BELOW DENISON DAM
ARKANSAS, LOUISIANA, OKLAHOMA, AND TEXAS
COMPREHENSIVE BASIN STUDY

APPENDIX XII

OUTDOOR RECREATION

Prepared by
U. S. Department of the Interior
Bureau of Outdoor Recreation

June 1968

This appendix was prepared by the Bureau of Outdoor Recreation as the chairing agency of the ad hoc Recreation Work Group Committee. The information and data herein were supplied, developed, and coordinated by members of the Work Group Committee.

SYLLABUS

INTRODUCTION

This is a report on the outdoor recreation resources of the lower Red River Basin, Louisiana, Arkansas, Oklahoma and Texas. Based on studies conducted by the recreation work group, a plan of development is suggested for implementation to meet the basin's outdoor recreation needs. This comprehensive study for the lower Red River Basin, is one of the original 16, later reduced to 15, Type II studies for the United States which were selected by the Interdepartmental Staff Committee of the ad hoc Water Resources Council for completion by 1970. Subsequently, the Water Resources Council was made a permanent body by the Water Resources Planning Act, Public Law 89-80, approved July 22, 1965.

Recreation Resource Area

The lower Red River Basin drains parts of four States, a total of about 29,000 square miles. The economic study area includes 19 counties of northeast Texas (26 percent of the study area), 13 counties of southeast Oklahoma (27 percent), nine counties of southwest Arkansas (12 percent), and 19 parishes of northwest Louisiana (35 percent).

The study area lies within three major physiographic provinces--Central Lowlands and Ouachita province in Arkansas and Oklahoma and the Coastal Plain in Louisiana, Arkansas, and Texas. For planning purposes, two relatively distinct recreation resource areas are recognized: the upper mountainous and low rolling hills, and the lower coastal plain area. The dividing line would be approximately at the city of Texarkana.

The upper area is influenced by the Ouachita and Arbuckle Mountains, with altitudes up to 2,850 feet. This area is relatively unspoiled and abounds in a variety of recreation resources. Except for the western portion, this area is forested with pine-hardwoods and drained by clear, unpolluted streams, many of which have been impounded for flood control, power, recreation, and other purposes. The area is sparsely populated with only 22 percent of the basin population and has an economy primarily based on agriculture and forestry. The area contains 56 percent of the public lands and 30 percent of the existing recreation water resource of the study area. It has 25 percent of the basin's developed recreation facilities and an outstanding potential not presently utilized.

The lower coastal plain area is influenced by the vast Mississippi River alluvial valley. The northern portion of this area is low rolling hills blending into an alluvial plain. The Red River and its tributaries have slow gradients and meander through broad valleys which have formed many oxbow lakes and swamps. These areas are a vital part of the area's recreation resources. Due to the more level topography, this area is restricted in suitable sites for large impoundments. Except for the western section, the area has an abundance of natural vegetation. It has numerous perennial streams, but most receive pollution in varying degrees. In some sections, stream pollution is restricting recreational use.

The area has 78 percent of the basin's population and an economy more industry oriented. The area contains 44 percent of the public lands and 70 percent of the existing recreation water resource of the study area. It has 75 percent of the developed facilities; however, about 70 percent of these facilities are located on only two reservoirs.

Recreational Opportunity Needs

The recreation market area or area of influence on the basin consists of the basin's resident population plus portions of eight outlying Standard Metropolitan Statistical Areas (SMSA's). This aggregate population was 1.9 million in 1965 and is expected to increase to 4.4 million by 2020. The 1965 average per capita personal income was $1,680 and is expected to increase to $6,000 by year 2020. These two factors plus anticipated increases in leisure time will contribute to increasing demands for recreation opportunity.

The demand for recreation opportunity is expected to increase from 37 million activity occasions in 1965 to 300 million in 2020. Boating, swimming, camping, and picnicking which constitute about 45 percent of the total recreation demand are expected to increase from 18 million activity occasions in 1965 to 148 million in 2020. This represents a total future demand increase of over 800 percent.

Existing recreation facilities can presently accommodate 1.7 million activity occasions of boating, swimming, camping, and picnicking. At present, there is a surplus of boating water in the basin as a whole. Programmed expansion of existing facilities by 1970 can accommodate an additional 2 million activity occasions. Unless additional areas and facilities are developed in the basin by 1980, there will be a shortage of 16 million activity occasions of swimming, camping, and picnicking. The demand for boating will be effectively satisfied.

When comparing projected demand with supply, there is an abundance of recreation water but a shortage of facilities. The existing recreation water will effectively meet the needs for boating opportunity through 1980. There is a shortage of facility development in the basin now and the shortage will increase greatly in the future. A major portion of all outdoor recreation demand through 1980 could be effectively satisfied with proper facility development and utilization of existing resources.

Problems and Corrective Opportunity

Basinwide, the existing water and land resource provides a firm base for meeting the early-action needs with proper development. However, there is a distribution problem of these resources. The problem is more of a specific type than one involving the total resource. Louisiana has an abundance of water but most of it is better suited for fishing than water skiing or boating because of heavy tree growth.

Access is one of the most evident problems confronting the basin. For the most part, the Red River main stem is closed to the public. It could easily satisfy 1 million recreation days annually if adequate access was provided.

Pollution is restricting recreational use of many water areas in the basin. If the waters of the basin are to offer additional recreational opportunity, established water quality standards must be enforced.

The growing economy of the basin is annually reducing the acreage of land available to outdoor recreation. With the expected population growth, plus the increasing growth of industry, agriculture, and urban development, the availability of land for general outdoor recreation will continue to decrease. These demands for land are placing an ever-increasing need on all elements of the recreation industry for a continuing program of sound long-range planning.

Vast areas of the basin's ecosystems are being altered as a result of clearing, drainage, and stream-flow alterations. There is a definite need for the States to establish environmental preservation programs through legislative authority if they are to preserve some of their natural ecosystems.

Land-use management programs are a definite need in the basin. Land-use controls such as easements, zoning, and rights-of-way corridors could insure the protection, enhancement, and orderly development of recreational resources. Flood plain zoning should be studied as a means of achieving a balanced land management program.

APPRAISAL

When compared to adjacent basins, the Red River Basin seems to be without any natural features which would draw recreationists to it in preference to adjacent basins. The Red River Basin should be considered recreationally important for the local or regional residents. The natural features present in the basin offer quality resources that will satisfy the outdoor recreational desires of its population if developed and/or preserved.

The basin's subhumid summer climate lends itself to outdoor activity. The changing vegetative characteristics of the spring and fall seasons, together with their pleasant weather conditions, allow and encourage additional outdoor recreation participation during these periods. The winter season, although restrictive for limited periods, permits frequent visitation to an outdoor setting.

Ideal reservoir locations, free-flowing streams, the broken topography, and the abundance of vegetation, wildlife, and open space, give the upper or northern portion of the basin outstanding outdoor recreational potential.

The southern portion has numerous streams, and an abundance of vegetation, and wildlife which offer outstanding potential for supplying recreational opportunities.

Plan of Development

The goal of this plan is to meet the recreation needs of the market area and to provide an equitable distribution of opportunity insofar as practical. Programs must continue to take full advantage of the basin's recreation potential. Consideration must be given to the preservation of a balanced land-use program which is essential for maintaining a quality environment for human habitation. Additional water areas will be needed to meet the ever-increasing future demand for boating and related activities. However, provision must be made to preserve some of the basin's streams and natural lakes to provide a variety of recreational opportunity.

With these goals in view, a development plan for the early-action period has been formulated as follows:

(1) The expansion of existing facilities at State, local, and Federal parks and recreation areas.

(2) An access and facility development at selected points on the major streams and at natural lakes and publicly owned land areas.

(3) Highway and access road development.

(4) Several free-flowing streams and adjacent lands for preservation.

(5) Maintenance of high-quality water in the basin's streams.

(6) 12 recreation areas to be developed on U.S. Forest Service lands.

(7) 22 large multiple-purpose reservoirs and the enlargement of two existing reservoirs with recreation as a project purpose.

(8) 22 small upstream reservoirs for multiple-purpose development.

(9) The bank stabilization and navigation project with recreation facility development.

(10) Expansion of the service industries and tourist information service.

Benefits and Costs

The average annual recreational benefits from the early-action plan are estimated to be in excess of $18 million. These benefits exclude any impact benefits that might be realized from these projects.

Costs of multiple-purpose reservoir developments have been estimated to be $390 million. Of this cost, $35 million is for recreation facility development. These costs would be shared for the most part between Federal, State, and local interests in accordance with established laws and policies.

Discussion

It is evident that the lower Red River Basin affords many excellent opportunities to achieve a balanced program of recreation resource development in harmony with other programs of land and water use. The achievement of this goal, however, will require that greater consideration be given to a balanced land and water use program. Full development of water and land for commercial uses must be tempered with the realization that stream and lake preservation and the establishment of natural areas must be a part of the overall program.

Conclusion

It is suggested that the 10 - 15 year plan as presented herein be adopted as an integral part of the Red River Basin Comprehensive Plan.

Public Camping Area - Beaver Bend
State Park, Oklahoma.

APPENDIX XII

OUTDOOR RECREATION

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APPENDIX XII

OUTDOOR RECREATION

SECTION I - INTRODUCTION

1. AUTHORITY

a. The Bureau of Outdoor Recreation is authorized to engage in water and related land resources programs through the Coordination and Development Act of May 28, 1963 (77 Stat. 49).

b. The Federal Water Project Recreation Act (79 Stat. 213) requires that the views of the Secretary of the Interior, with respect to outdoor recreation, be set forth in any report on a project or part of a project within the provisions of the Act, in accordance with Section 3 of 77 Stat. 49, and the Land and Water Conservation Fund Act of 1965 (78 Stat. 897).

c. At their September 22, 1964, meeting, the Coordinating Committee for this comprehensive study, suggested that the agency having primary interest in a particular function be charged with effecting coordination of work with other interested agencies and States. This could be accomplished by the formation of a work group and by directing informal meetings.

2. PURPOSE

a. The overall objective of this comprehensive study of the water and related land resources of the lower Red River Basin was to determine the best use, or combination of uses, of these resources to meet all foreseeable short- and long-term needs in the basin.

b. The purpose of this study is to develop a general recreation plan for the Red River Basin that will permit optimum utilization of the recreation resources to meet identified needs within the next 10 - 15 years.

3. SCOPE

This study includes an inventory of existing public outdoor recreation areas encompassing recreation activities grouped into three categories: (1) those dependent on water; (2) those enhanced by water; and (3) other activities. Particular emphasis has been placed on determining the demand, supply, and needs of the outdoor recreating public in the basin; appraising recreation potentials, both public and private; evaluating the extent of short- and long-range development programs; and recommending specific action to meet the demand for outdoor recreation activities within the next 10 - 15 years.

4. BACKGROUND

a. This comprehensive study for the lower Red River Basin, is one of the original 16, later reduced to 15, Type II studies for the United States which were selected by the Interdepartmental Staff Committee of the Ad Hoc Water Resources Council for completion by 1970. Subsequently, the Water Resources Council was made a permanent body by the Water Resources Planning Act, Public Law 89-80, approved July 22, 1965. Members of the council are: the Secretary of the Interior, Chairman; the Secretary of Agriculture; the Secretary of the Army; the Secretary of Health, Education, and Welfare; the Secretary of Transportation; and the Chairman of the Federal Power Commission.

b. Representatives of the Office of the Chief of Engineers, the lower Mississippi and Southwestern Divisions, and the New Orleans and Tulsa Districts of the Corps of Engineers decided at a conference in New Orleans on October 25-26, 1962, that, in keeping with the comprehensive (Type II) basin planning concept of Senate Document 97, the existing study should be expanded to include the entire Red River Basin below Denison Dam but exclusive of the Ouachita-Black River Basin. The Corps of Engineers would be responsible for the preparation and submission of the report which would be fully coordinated with other Federal, State, and local agencies having planning interests.

c. Following the conference, a plan of survey for the comprehensive study was drafted. Coordination was established and maintained through numerous work group meetings of the participating agencies. Work proceeded on the basis of agreements reached at the field level during fiscal years 1963 and 1964. The Bureau of Outdoor Recreation became a participant in August 1964.

5. PLANNING CONCEPT

The planning approach is based upon the concept that the aim of water and related land resources programs is to satisfy human needs and desires. Outdoor recreation, possessing both tangible and intangible values, is considered to be a desirable product of water and related land resources development programs.

6. PLANNING ASSUMPTIONS

a. Basin participation rates for outdoor recreation activities will be the same as those derived from participation data of the 1965 Survey of Outdoor Recreation Activities.

b. Such participation rates bear a direct relationship to per capita personal income and can be adjusted for local areas.

c. Participation rates which refer to populations "12 years old and older" may be applied to total populations since much of the outdoor recreation activity involves an entire family with all members occupying space and utilizing facilities.

d. Population and per capita income projections will follow the patterns projected by the Corps of Engineers in Appendix I, Economics, to the Red River below Denison Dam comprehensive report.

e. The level of participation per $1,000 per capita personal income will remain constant through the target years, 1980 and 2020.

7. PLANNING CRITERIA

The following criteria were utilized in arriving at supply, demand, and needs in terms of facilities.

a. Average summer Sunday demand - The average summer Sunday demand is an important concept in recreation planning because it is the basis for estimating land, water, and facilities required to meet demands. Average summer Sunday demand for all activities except camping was computed by dividing the total summer demand figure for each activity by 13 (13-week summer base) and multiplying by 0.4 to determine the Sunday demand. The weekly demand for camping is multiplied by 0.75 (to allow for the tendency for campers to remain 2 days, Saturday and Sunday, in the same site). Facility needs for the various activities are then computed by applying the following criteria.

b. Camping capacity - Acquisition of land for camping development should allow for access roads, parking spaces, washrooms, other improvements, and land to be left in a natural state. It is reasonable to plan no more than one campsite per acre of undeveloped land. The capacity of fully usable and developed land is based upon five persons per family unit, three family units per acre, or 15 activity occasions per developed acre. No turnover factor was employed for camping or other overnight facilities. Tent and trailer camping spaces were combined using the same units. The reported capacities for group camping areas for cabins were also added to the combined totals to arrive at a total supply capacity figure. Cabin-type camping capacity was estimated to be about seven persons per cabin the same as that determined by the Outdoor Recreation Resources Review Commission (ORRRC) studies.

c. Picnic capacity - Daily picnic capacity was determined as five persons per table and a maximum of seven tables per developed acre. A turnover of 2 per table was used since it corresponds to experienced use at Federal reservoirs. The above figures assume the use of suitable land. To allow for a moderate amount of unusable land and access areas, a figure of two tables per acre was used for

land acquisition. In areas more than 50 miles from urban areas, a turnover of 1.25 was used to allow for longer use of tables as a family center of activities.

d. Boating and water skiing - Daily boating capacity was based upon the supposition of one boat per 6 acres of water, with an average party of three persons per boat. For planning purposes, no turnover factor is employed since it is assumed that seasonal and daily variations affecting boat use (such as early morning and spring or fall fishing) would tend to balance cyclic demand periods when a turnover factor would normally be employed. Individual site characteristics, however, might require the use of the turnover factor in special areas. Canoeing capacity was based on an average of three persons per canoe and one canoe per mile of stream.

e. Boat launching areas - A 16-foot boat ramp, associated parking, access, and maneuvering space were planned on the basis of 2 acres of undeveloped land per ramp. This allowed for unsuitable topographic features and a limited amount of landscaping. In terms of fully usable land, one ramp unit with parking for 40 cars with trailers will require approximately 1 acre. There should be a launching ramp for each 40 cars with boat trailers anticipated on the average summer Sunday.

f. Swimming areas - Public swimming sites require 3 acres per 200 swimmers: 1 acre parking, 1 acre facilities and landscaping, and 1 acre beach and water. This provides over 200 square feet of beach per swimmer. Using a turnover factor of 3, 3 acres supply 600 swimming activity occasions per day. Swimming pool capacities have been individually computed by deducting from the total area of a given pool 1,000 square feet for a diving area; dividing the remainder by 30 square feet per swimmer; and multiplying by a turnover factor of 3.

8. DEFINITIONS

The following definitions have been used in this report:

a. Activity occasion - Participation by one person in one activity in 1 day. A person participating in three different activities in 1 day would be counted as three activity occasions.

b. Comprehensive - Used with "outdoor recreation," referring to all recreation activities dependent upon an outdoor environment. When used with "river basins" it refers to multiple-purpose development planning.

c. Design load - The facilities required to satisfy the average summer Sunday demand.

d. Outdoor recreation - Leisure time activities which utilize an outdoor setting.

e. Outdoor recreation activity - A specific leisure time action or pursuit in an outdoor environment.

f. Programmed - An approved and financed schedule of events directed toward effectuating a given outdoor recreation development plan or project within the early-action period.

g. Public access - Any recreational area or facility open to the general public, publicly or privately owned, with or without a fee charge.

h. Recreation area - An area of land or water administered as a unit for outdoor recreation use.

i. Recreation day - A standard unit of use consisting of a visit by one individual to an outdoor recreation development or area for recreation purposes during any reasonable portion or all of a 24-hour period, measured from midnight.

j. Recreation demand - An estimate of the amount and kind of outdoor recreation opportunities or facilities which the public desires, expressed in terms of activity occasions.

k. Recreation facilities - Those improvements provided to enhance recreation use.

l. Recreation Market Area - The area of influence from which users are drawn on 1-day outings, weekend trips, or both, to the project area.

m. Recreation needs - Unsatisfied demands translated into resource requirements in terms of land, water, and facilities.

n. Recreation supply - The capacity of recreation resources and facilities in terms of activity occasions, expressed as annual, seasonal, daily, or instantaneous capacity.

o. Site - A tract of land within a recreation area designated for a particular activity.

p. Summer - The summer period is considered to be the months of June, July, and August, or 13 weeks.

q. Unsatisfied demand - The difference between outdoor recreation demand and the capacity of existing and programmed resources, expressed in activity occasions.

9. ACKNOWLEDGMENTS

a. Much of the data used in the preparation of the supply portion of this report was obtained from the Nationwide Inventory Forms (BOR 8-73) as completed and furnished to the Bureau of Outdoor Recreation by the following State agencies: Arkansas Parks and Publicity Commission; Arkansas Game and Fish Commission; Louisiana State Parks and Recreation Commission; Louisiana Wild Life and Fisheries Commission; Louisiana Forestry Commission; Oklahoma Department of Wildlife Conservation; Oklahoma Industrial Development and Parks Department; Oklahoma Historical Society; Texas Parks and Wildlife Department; Sabine River Authority of Texas; and the several cities and towns in the four States in the Red River Basin area. The liaison officers, designated by the Governors of the four basin States for coordination of planning activities with the Bureau of Outdoor Recreation, were the focal points for obtaining the statewide inventories which provided the data.

b. The respective State Soil and Water Conservation Districts supplied, from their National Association of Conservation Districts (NACD) inventory forms, data on the private recreation sector.

c. Considerable data and assistance were provided by the Bureau of Sport Fisheries and Wildlife, Soil Conservation Service, U.S. Forest Service, and the Corps of Engineers.

d. Population, per capita personal income, and other socioeconomic data for the basin were provided by the Red River below Denison Dam Economic Base Study Work Group. Members of the Recreation, Fish and Wildlife, and other interagency work groups also contributed considerable data and assistance in coordinating and developing the general format, subject matter, and revisions of this report.

SECTION II - GENERAL DESCRIPTION OF STUDY AREA

1. PHYSICAL

a. The economic study area for the lower Red River Basin covers a total of about 29,000 square miles, including 19 counties of northeastern Texas (26 percent of the study area); 13 counties of southeastern Oklahoma (27 percent); nine counties of southwestern Arkansas (12 percent); and 19 parishes of Louisiana (35 percent).

b. The basin area lies within three major physiographic provinces--Central Lowlands and Ouachita provinces in Arkansas and Oklahoma and the Coastal Plain in Louisiana, Arkansas, and Texas.

(1) The Ouachita Mountains are about 250 miles long with altitudes of up to 2,850 feet. In the east they rise from under the Coastal Plain as rather simple folds, but westward the faulting increases. At the west end, the Ouachita Mountains are cut off by a fault; then after a gap, their structure is seen again in the Arbuckle Mountains.

(2) South of these mountains, extending from the Mississippi River to the Great Plains region in western Texas, lies the West Gulf Coastal Plain. The boundary between this region and the Ouachita Province is at the inner, or landward, edge of a mildly rolling, forested belt of sand which is generally less than 10 miles wide. Sandstone outcropping above the surface is evident throughout this region.

(3) The western limits of the study area coincide roughly with the boundary of the Grand Prairie. This almost level plain, with its fusion into rather steep slopes where eroding valleys cut into or through the underlying limestone beds, gives an angular appearance to the landscape.

(4) East of the Grand Prairie region lies the Blackland Prairie. The heavy clay soils of this region are very productive under good management, and it is one of the foremost agricultural areas of Texas. The area is noted for its limited underground water supply. The main water supply is from cisterns and reservoirs.

(5) To the east and south of the Blackland Prairie, the soils become intermixed with sand but retain the black color and calcareous character. The topography is gentle throughout this belt with trees appearing sparingly. The zone is classed as a marginal prairie. Beyond this transition zone, the soils vary from sandy loam to sand, with forests

becoming prevalent as underbrush and timber stands increase. The area extends into northeastern Texas and northwestern Louisiana where the outcropping of sandy beds is an important element in making the extensive, sandy, rolling, forested surface of this area.

(6) Further to the south in Louisiana is the southern Coastal Plain. This area is predominantly alluvial material. It is almost untouched by erosions except for the steep-sided channels of transverse streams. Dense growth of vegetation is found throughout this area.

(7) The climate of the basin is subhumid, with average annual precipitation ranging from about 39 inches in the west to 60 inches in the lower east portion. The average annual temperature varies from 60° F. in the west to 66° F. in the east. Extremes of heat and cold have ranged from about 118° F. to about -22° F.; however, these extremes are usually short in duration. The basin's summer climate lends itself to outdoor activity except for limited periods. The changing vegetative characteristics of the spring and fall seasons, together with their pleasant weather conditions, allow and encourage additional outdoor recreation participation during these periods. The winter season, although restrictive for limited periods, permits frequent visitation to an outdoor setting.

These climatic conditions plus the topographic and vegetative characteristics give the basin desirable features for offering recreation opportunity.

c. The River and Its Tributaries[1] - The Red River has its source, or upper limit, in the eastern portion of the State of New Mexico. Frio and Tierra Blanca Creeks rising near the New Mexico-Texas State line in Curry County, New Mexico, flow to the east into Prairie Dog Town and North Fork Rivers. The junction of the Prairie Dog Town and North Fork Rivers forms the main stem of the Red River. From this point, the river flows about 1,000 miles to its confluence with the Mississippi River.

(1) As the Red River flows to the east, it is fed by numerous stream systems, including those of the Wichita and Washita Rivers. Denison Dam, forming Lake Texoma, is situated at the junction of the Washita and Red Rivers. This marks the upper limit of the lower Red River which is being considered in this report.

(2) Below Denison Dam, the river continues its flow to the east, joined by numerous tributary streams. The principal tributaries between Denison and Texarkana flow south out of the Arubckle and Ouachita Mountains and include the Blue River, Boggy Creek, the Kiamichi River, and the Little River.

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1. See Map 2, Page XII-78

(3) At Fulton, Arkansas, 19 miles northeast of Texarkana, the Red River swings abruptly south. The Sulphur River, which flows easterly 150 miles parallel to and just south of the Red River, enters the Red about 25 miles southeast of Texarkana.

(4) As the river flows southeastward over the Louisiana Gulf Coastal Plain past Shreveport, Natchitoches, and Alexandria, its course and tributary system show the effects of the Red River rafts, a feature which has long made the river famous. In the 15th century, the formation of a log jam, masses of driftwood, tree trunks, and debris began in the vicinity of Alexandria and gradually piled up forming what is called the "Great Raft." Log jams were successively formed upstream with a gradual buildup to a length of 160 miles, reaching almost to the Arkansas State line.

(5) The immediate effect of these obstructions was the deposition of mud and sand and the leveling of the flood plain until new courses were adopted by the river at various places. Another effect of the decreasing grade was the creation of lakes and ponds in the tributaries, some as much as 25 miles in length.

(6) In 1873, the rafts were removed; all channels at once began to degrade and the lakes began to shrink and disappear. Within 20 years, the channel of the river near Shreveport was lowered about 15 feet. Riverbanks of 25 feet or more are common in the area today. The river is now characterized by fluctuations in water levels, caving banks, and unpredictable shoaling conditions.

(7) The principal tributaries and old abandoned channels in the Louisiana portion of the basin include Twelve Mile Bayou, Bayou Pierre, the Cane River, Bayou Boeuf, Bayou Cocodrie, and Bayou des Glaises on the southwest bank, and Bayou Bodcau, Bayou Dorcheat, Black Lake Bayou, Saline Bayou, and the Little River on the northeast bank.

(8) The effect of the "Great Raft" on the recreation potential lies in the number of channels and shallow lakes which were created. These bodies of water greatly increase the possibilities for sport fishing and use of small boats. Plans presently being considered for deepening some of the old river channels, as well as the main stem, will greatly enhance boating possibilities if they are implemented.

2. SOCIOECONOMIC

a. Population - Approximately 1.5 million persons lived in the lower Red River Basin drainage area in 1960. Of this, about 9

percent lived in Arkansas, 49 percent in Louisiana, 15 percent in Oklahoma, and 27 percent in Texas. This 1960 figure represents a slight overall decline in population of 1.5 percent since 1950.

(1) Of the 60 counties and parishes included in the basin study area, only six parishes in Louisiana and three counties in Texas showed gains in population between 1950 and 1960. These gains were associated with urban growth. The remaining 15 parishes in Louisiana, 16 counties in Texas, all nine counties in Arkansas, and all 13 counties in Oklahoma suffered population losses during this period.

(2) The largest population gains were recorded in those counties adjacent to the Shreveport-Bossier City area and Alexandria, Louisiana; and the Denison-Sherman, Texas, area. Although the city of Texarkana showed a gain in population from 40,638 in 1950 to 49,006 in 1960, the host counties of Miller, Arkansas, and Bowie, Texas, showed overall declines of 2.8 percent and 3.2 percent, respectively, in their total population.

(3) The two major cities inside the basin are Shreveport, Louisiana (1960 population of 164,300), and Texarkana, Arkansas (1960 population of 50,000). Both are located in the central portion of the basin. The third largest urban area is Alexandria, Louisiana (1960 population 40,279).

(4) Total basin population declined 23,695, or 1.5 percent, during this same period. These changes resulted from shifts within the basin, with a few urban areas attracting almost as many newcomers as the basin lost in local residents. Of the total population in the area, 740,000, or approximately 46 percent, resided in urban areas. This percentage is, however, much lower than the figures for the United States collectively, which show approximately 70 percent of the total population residing in urban areas. Shifting or transplanting of the population from rural to urban, or small to larger urban areas, is not unique to the basin. These same characteristics are evident throughout the Nation. Most of the small towns and rural areas are made up of older people, with the younger people seeking the employment and amenities of urban life. This transition has brought about sprawling cities with expanding industries and spreading suburbs filled with people basically divorced from the out of doors.

(5) There are several major cities, Standard Metropolitan Statistical Areas (SMSA's), outside the study area that can be expected to have a significant effect on the recreation demand in the area. These cities and their 1960 populations are: Dallas, Texas, 1,083,600; Fort Worth, Texas, 573,200; Oklahoma City, Oklahoma, 511,800; Fort Smith, Arkansas, 135,100; Monroe, Louisiana, 101,600; Tyler, Texas, 86,300; Lake Charles, Louisiana, 145,400; and Baton Rouge, Louisiana, 230,000. With the

exception of Fort Smith, Arkansas, each of these cities reported population increases ranging from 25 to 60 percent for the 1950 and 1960 decade.

b. Economy - During periods of low flow, the water of the lower Red River is considered to be generally unsuitable for most municipal and industrial uses due to its high content of dissolved solids and chlorides. The presence of these natural and manmade pollutants also adversely affect the outdoor recreational potential of the Red River's main channel.

(1) Dependable navigation of the river is presently confined to the water below Alexandria where a depth of 6½ feet or more is available throughout the year. During periods of high-water level, some barges still travel up the river to the vicinity of Shreveport, but the volume of this traffic as a factor in the area's economy is negligible.

(2) Industries in the basin include the lumbering of pine and hardwood, the production of pulpwood and paper, and the manufacturing of plywood. Mining, quarrying of native building materials, and the processing of agricultural and mineral products are also important, particularly in the central basin area between Shreveport and Texarkana.

(3) Mineral deposits and quarry products of economic significance in the basin are petroleum, natural gas and gas liquid, clay, sand, gravel, stone, and cement. In addition to these, iron deposits are found in northeastern Texas where a steel mill is in operation at Daingerfield in Morris County. A large portion of the Nation's proven natural gas reserves and proven petroleum reserves is found in Texas and Louisiana.

(4) Historically, cotton has been the primary agricultural commodity of the basin and has accounted for the development of many large plantations along the river. It was the primary incentive that brought about the opening of a navigable channel and the rapid growth of river traffic during the latter part of the 19th century. However, the character of today's agriculture has changed with cotton no longer occupying its former position of preeminence.

(5) Agriculture is the predominant activity throughout the basin area, with diversified farming being practiced in conjunction with livestock raising, dairying, and poultry farming. Major crops include truck crops (fruits, vegetables, watermelons), cotton, corn, soybeans, small grains, and hay. Today, more and more land is being cleared for crops and a problem of dwindling natural cover for the protection of wildlife is becoming serious in many areas.

(6) Timber production is economically significant in the basin with stands varying from cypress in the southern part to pine-hardwood in the northern section. The stream bottom supports various species of hardwood. The western section of the basin supports limited amounts of oak, elm, and cottonwoods, most of which is scrubby and considered non-commercial in value.

Public swimming area - Beaver Bend State Park, Oklahoma.

SECTION III - DEMAND, SUPPLY, AND NEEDS

1. RECREATION MARKET AREA

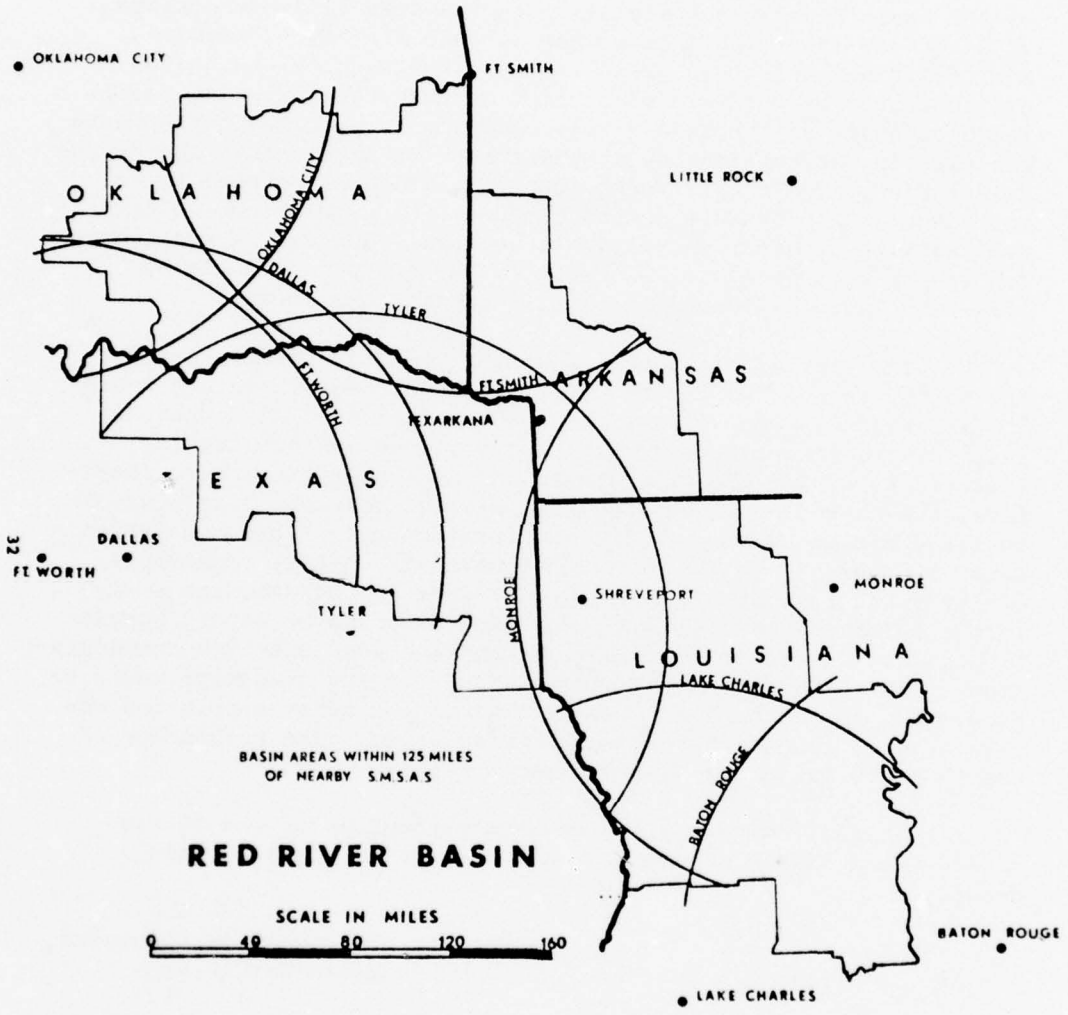
a. The recreation market area is an area from which users of the basin's resources are drawn to the area on 1-day outings or a weekend (overnight) trip (Map 1, Page XII-14). Standard Metropolitan Statistical Areas (SMSA's) influencing the basin are indicated by the arcs of circles representing 125-mile radii. The percentage of the SMSA circle occupying a portion of the basin was used in determining the proportion to be included in the demand calculation. The Little Rock, Arkansas, SMSA was omitted as an influence on the basin's demand because of its location and the availability of other recreation resources. However, a small percentage of this SMSA will recreate in the basin but should be offset by basin residents recreating outside the area.

b. The problem of "double counting" was experienced between the Red River and the Sabine River Basins recreation market areas. The Interagency Recreation Work Group decided that although the two basins were contiguous, neither possessed any outstanding features to draw recreationists to one area over the other; therefore, the shared counties should be divided as closely as possible on the drainage boundary. The remaining counties were considered to be 100 percent in the basin (for population only) regardless of the percentage of the total county area in the drainage basin. This eliminated the need for percentage division of county population data. The Interagency Work Group also gave thorough consideration to the SMSA's from which an obvious portion of demand would be generated. In each case, a percentage of the urban population was allocated to the basin for demand calculation. The percentage of the SMSA population was derived mechanically.

c. The following table gives the percentage of the shared counties and SMSA's population used in calculating the basin's demand:

Shared County or Parish	Percent of Population Allocated to Basin Market Area
Hunt County Texas	20
Hopkins County, Texas	80
Upshur County, Texas	50
Harrison County, Texas	50
Gregg County, Texas	50
Panola County, Texas	10

Map 1


OKLAHOMA CITY
FT SMITH
LITTLE ROCK
OKLAHOMA
OKLAHOMA CITY
DALLAS
TYLER
FT SMITH
ARKANSAS
FT WORTH
TEXARKANA
TEXAS
DALLAS
FT WORTH
TYLER
MONROE
SHREVEPORT
MONROE
LOUISIANA
LAKE CHARLES
BATON ROUGE
32
BASIN AREAS WITHIN 125 MILES
OF NEARBY S.M.S.A.S
RED RIVER BASIN
SCALE IN MILES
0
40
80
120
160
BATON ROUGE
LAKE CHARLES

De Soto Parish, Louisiana	40
Sabine Parish, Louisiana	10
Vernon Parish, Louisiana	10
SMSA's	
Dallas, Texas	10
Fort Worth, Texas	5
Tyler, Texas	27
Oklahoma City, Oklahoma	10
Fort Smith, Arkansas	5
Shreveport, Louisiana[1]	90
Monroe, Louisiana	11
Baton Rouge, Louisiana	5
Lake Charles, Louisiana	5

2. DEMAND

a. The procedure used to calculate the outdoor recreation demand is the participation rate-per capita personal income approach. The basis of this approach is the outdoor recreation participation data derived from the 1965 Survey of Outdoor Recreation Activities and the population and per capita personal income for the study area as determined by the economic base study.

b. Demand projections for boating, swimming, camping, picnicking, and other activities were calculated for 1965, 1980, and 2020. These calculations are expressed as average summer Sunday, total summer, and total annual demand. The average summer Sunday demand projections are used throughout the report as the basis of all planning.

c. The calculated total average summer Sunday demand for the above activities, in activity occasions, except "other," are as follows.

Area	1965	1980	2020
Basin[2]	319,000	590,000	2,621,000
Arkansas	21,600	38,100	175,100
Louisiana	140,800	261,800	1,237,000
Oklahoma	41,600	70,300	286,000
Texas	115,400	219,700	923,000

1. Although the Shreveport SMSA is within the basin, it was agreed that 10 percent of the population could recreate outside the basin.

2. These figures are rounded.

Chart 1 shows the demand by activity for the basin. Charts showing the demand of the individual State are in the supporting data section of this report.

d. The demand, on a percentage basis, is much higher in the southern part of the basin. This is due to existing and projected resident population plus the proximity of large metropolitan areas outside the basin.

3. SUPPLY

a. The inventory of known existing public recreation areas and facilities was compiled from the Nationwide Inventory Forms (8-73). It was estimated, based on recommendations of the various States involved, that the private sector supplies the following percentages, in proportion to the public supply, of the total outdoor recreation supply: Arkansas, 3 percent; Louisiana, 15 percent; Oklahoma, 5 percent; and Texas, 10 percent.

b. January 1, 1963, was the cutoff date for a project or facility to be existing in this study. Any new project constructed after that date was included as part of the early-action plan. An expanding discussion of this rather unique situation may be found in section IV of this report.

c. Public facilities or areas existing as of December 31, 1962, were considered as the 1965 supply for this study. Programmed additions or improvements to these facilities or areas by 1970 were considered as the 1970 supply and used as the base to show the basin's ability to satisfy the demand if no new facilities or areas were developed. The estimated supply ability of the private sector remains constant through 1980 and 2020. A quantitative estimate was made as to the number of activity occasions the existing supply could accommodate on an average summer Sunday (See Chart 10, supporting data section). A total of about 283,000 activity occasions for swimming, boating, camping, and picnicking could be accommodated on an average summer Sunday in 1962. The programmed expansion, shown as the 1970 supply, increased this level to 408,000 activity occasions.

d. With the exception of Arkansas, all States were capable of satisfying their demand for general boating in 1965. Oklahoma showed a surplus capacity for swimming. All States showed a deficiency in picnicking and camping facilities. This study has revealed public reservoirs without a public boat launching ramp, parks with inadequate facilities, and major streams without access. In all instances, a good potential exists but it is not developed. Recent land acquisitions, the proposed bank stabilization and navigation project, and

proposed reservoir construction will, if developed, greatly increase the recreation supply in the basin. Charts 8 and 9, supporting data section, show the known public outdoor recreation areas with the existing and programmed improvements.

4. NEEDS

a. The basin shows an overall deficiency in facilities, except for boating, through 1980. If no new facilities are developed and the 1970 supply is maintained, the total needs of the basin will increase approximately sevenfold by 2020.

b. The approximate projected unsatisfied demand for the basin on an average summer Sunday for the target years 1980 and 2020 are as follows:

Activity	1980	2020
Boating	No Acres	908,000 Acres
Swimming	173 Acres	1,140 Acres
Camping	17,600 Units	90,000 Units
Picnicking	12,000 Tables	72,000 Tables

In the supporting data section, Charts 10 present additional information on the needs of the basin.

CHART 1

Red River below Denison Dam
Existing and Projected Population and Per Capita Personal Income

Area	1965 Population (1,000)	1965 Per Capita Personal Income	Population x PCPI (1,000)	1980 Population (1,000)	1980 Per Capita Personal Income	Population x PCPI (1,000)	2020 Population (1,000)	2020 Per Capita Personal Income	Population x PCPI (1,000)
Arkansas Subarea	156.6	1,464	229,200	191.9	2,103	403,600	329.0	5,617	1,848,000
Oklahoma Subarea	288.0	1,534	441,900	334.9	2,215	742,000	502.0	6,025	3,025,000
Louisiana Subarea	832.0	1,786	1,489,000	1,087.9	2,545	2,769,000	2,100.0	6,237	13,098,000
Texas Subarea	621.2	1,971	1,224,800	810.0	2,870	2,325,000	1,435.0	6,805	9,765,000
Total	1,897.6		3,384,900	2,424.7		6,239,600	4,366.0		27,736,000

Red River below Denison Dam
Existing and Projected Total Annual, Summer, and Average Summer Sunday Demand

Activity	Average Summer Sunday Participation Rate Per ($1,000)	Average Summer Sunday Demand in Activity Occasions (1,000)			Total Summer Participation Rate Per ($1,000)	Total Summer Demand in Activity Occasions (1,000)			Total Annual Participation Rate Per ($1,000)	Total Annual Demand in Activity Occasions (1,000)		
		1965	1980	2020		1965	1980	2020		1965	1980	2020
Boating	0.0226	76	141	626	0.730	2,470	4,554	20,237	1.470	4,974	9,180	40,774
Swimming	0.0270	91	168	749	0.880	2,978	5,489	24,405	1.230	4,162	7,668	34,103
Camping	0.0170	57	106	470	0.300	1,014	1,870	8,320	0.620	2,098	3,870	17,194
Picnicking	0.0280	94	175	776	0.930	3,147	5,802	25,791	1.990	6,736	12,416	55,191
Subtotal		318	590	262		9,609	17,715	78,253		17,970	33,134	148,262
Other Activities												
Playing Games	0.0050	17	31	138	0.192	650	1,197	5,324	0.840	2,841	5,240	23,292
Incidental Fishing	0.0030	10	18	83	0.112	379	698	3,106	0.270	911	1,684	7,487
Sightseeing	0.0280	94	175	777	0.915	3,095	5,709	25,378	2.950	9,982	18,405	81,815
Hiking	0.0030	10	18	83	0.103	349	641	2,851	0.210	711	1,309	5,823
Nature Walks	0.0080	27	50	222	0.287	971	1,790	7,957	1.430	4,838	8,921	39,658
Subtotal		158	292	1,303		5,444	10,035	44,616		19.283	35,559	158,075
Total		476	882	3,927		15,053	27,754	123,387		37,253	68,693	306,337

Note: Population x PCPI x Participation Rate = Demand in Activity Occasions
Note: Totals have been rounded.

SECTION IV - OUTDOOR RECREATION PLAN

1. GENERAL APPRAISAL

a. When compared to adjacent basins, the Red River Basin seems to be without any natural features which would draw recreationists to it in preference to adjacent basins.

b. In the absence of any outstanding natural features, the Red River Basin can be considered recreationally important only to the local or regional residents. The lack of unique natural features makes it advisable to develop or construct quality facilities that will satisfy the outdoor recreational desires of the basin's population.

c. The basin's subhumid summer climate lends itself to outdoor activity. The changing vegetative characteristics of the spring and fall seasons, together with their pleasant weather conditions, allow and encourage additional outdoor recreation participation during these periods. The winter season, although restrictive for limited periods, permits frequent visitation to an outdoor setting.

d. Ideal reservoir locations, free-flowing streams, the broken topography, and the abundance of vegetation, wildlife, and open space, give the upper or northern portion of the basin outstanding outdoor recreational potential.

e. The southern portion has numerous streams, and an abundance of vegetation, and wildlife which offer outstanding potential for supplying recreational opportunities.

2. APPRAISAL OF THE EXISTING AND POTENTIAL RECREATION RESOURCE

a. When the basin's existing public outdoor recreational resources are studied in terms of facilities (picnic tables, camping units, etc.), they are found to be in drastic need of improvement. The existing resources (land, water, etc.), offer an excellent potential for development. The resource is not now developed to its potential.

b. According to data from the Bureau of Outdoor Recreation's "Nationwide Inventory Forms 8-73," the basin has over 1.6 million acres of publicly owned lands with only approximately 9,000 acres actually developed for outdoor recreation. This does not take into consideration the vast areas open to such activities as sightseeing and nature walking. There are public reservoirs without constructed

boat ramps, others without any type of recreation facilities. This does not include such reservoirs as Atoka or Cross Lake which have restricted use because of their public water supply purpose. Basically, all perennial streams are closed to public access except where they cross public lands. There are large public hunting and/or game management areas that are being operated as single-purpose areas. The large acreage of national forest system lands in the basin is in need of additional outdoor recreation facility development.

c. Most of the towns or cities of the basin are without adequate parks and recreation facilities, and many State parks in the basin are vastly underdeveloped.

d. The desirability and potential of the numerous historical and archeological sites in the basin will be outlined and discussed in the Appendix IX to this comprehensive study.

e. For all activities except general boating, the existing water and related land resources have the potential to effectively satisfy the projected needs of the basin through year 1980. For this potential to be utilized, adequate facilities with related measures must be developed. The potential of the proposed water resource developments (reservoirs) and existing streams and natural lakes, will be depleted prior to year 2000. Additional water acreages in the form of impoundments must be constructed if the long-range recreation needs of the basin are to be satisfied.

3. APPRAISAL OF THE CAPABILITIES OF GOING PROGRAMS

a. The major programs of significance to the outdoor recreational development in the basin are: The Corps of Engineers navigation and bank stabilization project and multiple-purpose reservoirs; Soil Conservation Service upstream watershed reservoirs; U.S. Forest Service reservoirs and recreation facilities; reservoirs and related facilities proposed by the Texas Water Development Board which are exclusive of the preceeding programs; and the planning and development programs of the respective States.

b. The proposed navigation project will enable navigation up the Red River to Shreveport, Louisiana, then up Twelve-Mile and Cypress Bayous to Daingerfield, Texas. The bank stabilization project is from the mouth of the Red River to Denison Dam. The project proposes seven dams and locks, two locks and numerous bendway cutoffs resulting from the realignment of the river. Preliminary studies by the Corps of Engineers have revealed that approximately 35 access points and 15 bendways are feasible and have potential for recreational development.

c. The reservoir construction program by the Corps of Engineers will increase the supply of surface water for recreation, particularly in the northern part of the basin. Unfortunately, only one of the proposed reservoirs is south of Shreveport, Louisiana, where future needs are greatest. This is due to the topography of the southern part of the basin which does not lend itself to reservoir construction. The Corps of Engineers program consists of 22 reservoirs and the enlargement of Lake Caddo and Lake O'the Pines. Of these 22 reservoirs, eight are under construction or have been completed since this comprehensive study was started. There are also seven others authorized for construction.

d. The Soil Conservation Service has proposed 22 upstream watershed multiple-purpose reservoirs including recreation as a purpose; four single-purpose reservoirs serving either irrigation or municipal and industrial water supply; and 432 single-purpose flood prevention reservoirs. Construction is complete on two of the multiple-purpose sites and three others are under construction. One of these reservoirs if properly developed will supplement the supply for general boating water in the southern portion of the basin where localized needs exist. Most of the sites are located within one hour's driving time from cities or towns in the basin.

e. The U.S. Forest Service program consists of 12 new recreation areas, eight of which will provide water-contact recreation opportunities. The U.S. Forest Service also proposed additional facilities at existing sites. Through its multiple use planning and management program, it has identified numerous additional sites, but limited funds have prevented detailed studies and possible development as to their potential to offer recreational opportunities.

f. The reservoirs and related facilities of the preliminary Texas Water Plan will greatly increase the water acreage supply in the basin. This plan proposes one new reservoir and the enlargement of two existing Federal reservoirs (Texarkana and Lake O'the Pines).

g. Each State has developed a comprehensive outdoor recreation plan. These plans will aid the States in determining their needs and in scheduling development programs. Also the respective States have formulated and developed water quality standards which can be used as a tool for improving water quality to enhance recreational opportunity. Their respective Game and Fish Commissions are implementing additional programs to maintain and improve the supply of fish and wildlife which are vital to the total recreation program.

4. BASIC ISSUES

The basic issues affecting the recreational resources in the basin are multiple and complex. Like most of man's problems on earth, they are created by man in his attempt to shape his environment for his convenience without first considering basic ecological principles and conditions.

a. Pollution - The Red River above Lake Texoma has substantial natural pollution due to brine emission. Below Lake Texoma, the main stem and some tributaries receive quantities of inadequately treated waste from cities and industries and from agricultural operations. This situation restricts water-contact recreation in many areas of the basin. If the Red River and affected tributaries are to offer additional significant recreation potential, established water quality standards must be enforced.

b. Access - For the most part, all fishable and boatable streams in the basin are closed to the public because of restricted access. Much of the public land offering limited recreational opportunity is due to restricted access. The lack of a good road system into and within some areas of the basin is restricting use at this time since a weekend trip has a time-distance limitation for a majority of recreationists. Better distribution of the recreating public could be obtained if the basin had a well-balanced road system. The interstate highway system, once completed, will offer good access into and through the basin, but the secondary and primary systems must be improved in some areas.

c. Conflicting land use -

(1) Each year many large areas of the basin's natural vegetation are being cleared, drained and converted to agricultural, commercial or residential uses.

(2) Reservoir construction and other land management measures are removing large areas of bottomland hardwoods and are altering the natural ecology of the affected river or stream.

(3) The above-listed items are vital to our national economy, but reflect the ever increasing importance for sound long-range planning if we are to preserve even a small part of our nonrenewable resources.

d. Uncoordinated approach to planning and development -

(1) For the most part, Federal, State, and local agencies have not fully coordinated the planning and developing of recreational facilities.

(2) Public planning agencies have approached the field of recreation without established long-range goals that were correlated with the programs of all agencies. Some States are handicapped today due to previous political selection of parks and recreation areas without regard to the overall needs of the State or area.

e. Land-use controls - There has been an absence of the use of land-use controls such as easements, zoning, and other regulatory measures in the basin. These measures could be used to insure the protection, enhancement, and development of the recreational resource in the basin. Also, they could eliminate undesirable types of construction around the lakes, parks, and other recreation areas. They could be used to establish corridors for power and pipelines or highway routes to eliminate detraction from the natural beauty. These measures could aid in establishing guidelines for cluster type home and cabin development wherein open space areas are left for parks and playgrounds.

f. Service industry and publicity - The private personal services and facilities presently in the basin are insufficient to handle the existing demand. This condition can have a detrimental effect on use of recreational areas. There is also a shortage of information as to what, where, and how much recreational opportunity is available in the basin.

5. ESTABLISHMENT OF GOALS

The goal of this recreation plan is to offer an opportunity for outdoor recreation to the population in the recreation market area of the Red River Basin. It is intended that this plan will provide these opportunities efficiently and effectively to the extent practical within the potential and capability of the resource. Recreational opportunities can be encouraged through this plan, but they must be offered with emphasis on protecting the natural resources of the basin and utilizing them in a complementary manner.

6. ALTERNATIVES

a. The lower Red River Basin offers a variety of opportunities for developing a recreation plan. The available alternatives range from the development of large reservoirs to the preservation of free-flowing streams; the development of large amounts of forest land for recreation to the preservation of unique areas; and the development of existing resources to the construction of new resources.

b. Some of the alternatives considered in developing this recreation plan were:

(1) Expansion of existing recreation area versus development of new areas.

(2) Development of existing resources (lakes, streams, and related lands) versus construction of new resources for development.

(3) Preservation of ecological, historical, vegetative areas versus utilization of these areas by other uses.

(4) Distribution of the recreation resources within the populated areas versus the recreationist commuting to the resources.

(5) Tangible benefits versus intangible benefits in justifying recreation as a project purpose.

(6) Early-action programs versus long-range programs to meet future needs.

c. Consideration was given to the possibility of developing adjacent river basins as a means of satisfying some of the recreational demands of this basin. A comprehensive river basin plan has been formulated for the Sabine River Basin which is adjacent to and drains a large area to the west and south of the subject basin. The data available on the Sabine do not indicate a substantial surplus of supply over the projected needs. Toledo Bend Reservoir should draw recreationists from the basin, particularly the Shreveport Standard Metropolitan Statistical Area. Allowances for this were made in the demand calculation for the Louisiana and Texas subareas.

d. The Red River Basin possesses a variety of resources providing many alternatives for recreational development and use. Adding to its value is the remote setting of most of the various resources. This remoteness must be protected and preserved in any recreational planning and development.

7. FEATURES OF THE PLAN

a. The recreation plan, as developed by the Recreation Work Group, is outlined in two stages of development, early action and long range. Much of the early-action (10 - 15 years) recreation program and the long-range (after 1980) recreation program is shown on Map 2, page XII-78. Multiple-purpose and single-purpose projects as well as supporting programs are included. The multiple-purpose projects include outdoor recreation development as one of the purposes for construction (usually a water resource development). The single-purpose projects include the development of scenic areas, scenic drives, hiking trails, recreation complexes, preservation of free-flowing streams, stream access, and expansion of existing facilities.

b. All elements of the recreation plan involve either improvement of existing areas and facilities, development of new areas and facilities, preservation of outstanding natural resources, or expansion and acceleration of existing supporting programs. The recreation plan, framed by the type of program or project, scale of development, and time of development, is tabulated in Chart 2.

c. Early-Action Programs

(1) Enlargement of existing recreation areas, within their capacity and based upon expressed demand, whereby these sites will continue to offer high quality opportunity to the recreating public. See Charts 8 and 9 in the supplemental data section for listings by States.

(2) Access site developments (roads, land, and facilities) to the basin existing resources. Emphasis should be on utilizing existing lakes, streams, and land areas.

(3) There are several free-flowing streams in the basin that are worthy of preserving. Stream preservation is of utmost importance to the total recreation resource of the States and basin. The following streams are suggested for preservation:

Louisiana

-Saline Bayou in Bienville, Winn, and Natchitoches Parishes, 60 miles of stream
-Bayou Bodcau from Arkansas-Louisiana line to existing damsite in Louisiana, 40 miles of stream.
-Bayou Dorcheat above Lake Bistineau, 40 miles of stream.
-Black Lake Bayou above Black Lake, 70 miles of stream.

Arkansas

-Mountain Fork River, from Oklahoma State line, 15 miles of stream.
-Upper Cossatot River, upstream from Gillham Lake, 60 miles of stream.
-Upper Little River, upstream from Millwood Reservoir, 20 miles of stream.
-Bayou Bodcau above Lake Erling, 17 miles of stream.
-Bayou Dorcheat above and below proposed Dorcheat Reservoir, 15 miles of stream.
-Rolling Fork River above DeQueen Reservoir, 25 miles of stream.
-Saline River above Dierks Reservoir, 25 miles of stream.

CHART 2

FEATURES OF THE PLAN BY
SCHEDULE AND SCALE OF DEVELOPMENT 1/

TIME SCALE	EARLY ACTION	LONG RANGE
MULTIPLE PURPOSE	23 Corps of Engineers projects (d)	14 Corps of Engineers projects (d)
	22 SCS upstream reservoir for multiple-purpose development (d)	31 SCS upstream reservoir (d)
	Proposed Texas Water Development Plan (d) (1) 1 new reservoir (2) enlargement of 2 existing reservoirs	Proposed Texas Water Development Plan - 7 reservoirs (d) Expansion of recreation facilities on all early-action projects (i)
	Bank Stabilization and Navigation project (d)	
SINGLE PURPOSE	8 recreation lakes on USFS lands (d)	Additional recreation lakes and areas on USFS lands (d)
	Scenic drives, hiking and saddle trails (d)	Additional scenic drives hiking and saddle trails (d)
	4 USFS recreation areas (d)	Additional boat access (d)
	Boat access (d)	
	Free-flowing streams (p)	
	Expansion of State and USFS existing facilities (i)	Continuing expansion of recreation facilities on all single-purpose projects (i)
	4 SCS sponsored single-purpose reservoirs (d)	
PROGRAMS	Highway and access road development (d)	Expansion and continuation of early-action programs (s)
	Tourist information (s)	
	Expansion of service industries (s)	

1/ Listing does not imply order of priority.

Key:

(i) Improvement of existing areas and facilities

(d) Development of new areas and facilities

(p) Preservation of outstanding natural resources

(s) Expansion and acceleration of supporting programs

Oklahoma

-Muddy Boggy Creek from its mouth on Red River upstream to near Unger, Oklahoma (16 miles of stream).
-Kiamichi River from its mouth on Red River upstream to near Sawyer, Oklahoma (20 miles of stream).
-Blue River from near Milburn, Oklahoma, upstream for 20 miles of stream.
-Little River from Pine Creek dam downstream to the Arkansas-Oklahoma state line, for a total of 71 miles of stream.
-Mountain Fork River from Broken Bow reregulating dam downstream to the Little River junction, a distance of 11 miles of stream.
-Glover Creek from State Highway No. 3 downstream to its confluence with Little River for a distance of 10 miles of stream.
-Kiamichi River from near Tuskahoma downstream to near Antlers (29 miles of stream).
-Black Fork Creek from its junction with Little River upstream for 21 miles.
-Little River from near Honobia downstream to the upper end of Pine Creek Reservoir for a distance of 47 miles of stream.

(4) The following unique and/or scenic areas should be preserved, at least in part, for future use and enjoyment:

(a) The Shut-ins area on the upper Cossatot River, Arkansas;
(b) Grassy Lake in Hempstead County, Arkansas;
(c) The "Skyline Drive" area of southeastern Oklahoma;
(d) The Beaver Bend State Park area, Oklahoma; and
(e) The "Backwater" area at the confluence of the Red and Mississippi Rivers.

(5) A scenic highway has been constructed from Talihina, Oklahoma, to Mena, Arkansas. The extension of this scenic drive to Hot Springs, Arkansas, and possibly to Little Rock could give needed access and provide an additional attraction to the basin. Other potential scenic drives should also be explored for possible development.

(6) There are several areas of hardwood timber in the lower Red River Basin that should be acquired for preservation and wildlife management. These acquisition recommendations should be studied immediately so that possible early acquisition can be facilitated. Estimates of acreages involved are given in Appendix XIII and specific locations will be determined later pending investigations.

(7) There are many fishing and hunting oriented areas in the lower Red River Basin that could be developed to accommodate a greater variety of outdoor recreation activities. It is suggested that the repsective State Game and Fish Commissions provide facilities, wherever compatible, for other activities on areas under their control and management.

(8) Highway and access road development should be continued.

(9) There are some severe pollution problems in the basin, but water quality standards and control needs have been established by each individual State. These standards are described in Appendix XI of this study. At all recreation areas, at least secondary water-contact standards should be maintained; and where primary contact recreation is proposed, sufficient quality must be maintained to protect the health and welfare of man. The comprehensive plans should include assurance from the States that the required standard will be maintained.

(10) Historical and archeological sites in the basin have been inventoried in Appendix IX. Preservation of these values should be in accordance with the recommendations appearing in that appendix to this comprehensive study.

(11) The largest segment of the early-action construction program is the 22 Corps of Engineers multiple-purpose reservoirs; the navigation project on the Red River main stem and Twelve Mile and Cypress Bayous; the bank stabilization project from the mouth of the Red River Basin to Denison Dam; and the enlargement of existing Lake Caddo. These projects have the potential to satisfy nearly 16.8 million outdoor recreation days annually with optimum development. Implementation of the recreation development will be in accordance with existing laws at the time of construction and development. It is assumed that non-Federal public bodies will participate in the cost-sharing requirements for those reservoirs built under the jurisdiction of the Federal Water Project Recreation Act (Public Law 89-72).

Of the 22 Corps of Engineers reservoirs included in this study, 14 have been authorized of which eight have been constructed or are under construction at this time.

(a) Reservoirs completed or under construction since January 1, 1963:

Reservoir	Conservation Pool
Millwood	24,500 acres
DeQueen	1,680 acres
Dierks	1,360 acres

Gillham	1,370 acres
Broken Bow	14,200 acres
Pine Creek	3,800 acres
Hugo	13,250 acres
Pat Mayse	5,993 acres

(b) Reservoirs authorized for construction:

Reservoir	Conservation Pool
Cooper	19,270 acres
Big Pine	4,640 acres
Clayton	8,900 acres
Tuskahoma	11,600 acres
Lukfata	1,100 acres
Boswell	5,540 acres

(c) Proposed Multiple-purpose reservoirs:

Reservoir	Conservation Pool
Kisatchie	9,190 acres
Dorcheat	17,300 acres
Parker	6,170 acres
Bonham	5,280 acres
Albany	4,960 acres
Durant	8,980 acres
Liberty Hill	7,070 acres
Sherwood	30,740 acres
Caddo Lake Enlargement	27,000 to 35,600 acres

(12) In the next 10 - 15 years the scheduled expansion and improvement to the existing and the proposed developments of U.S. Forest Service recreation areas will be completed. To better meet the existing and future public needs for outdoor recreation, the U.S. Forest Service should enlarge their planning and development program to enable these lands to draw and satisfy a much larger share of the demand of the recreating public.

The following recreation areas will be constructed during the early-action period:

-Dogwood Recreation Area
-Livington Recreation Area
-Magnolia Recreation Area
-Stuart Lake, 3 acres of water
-Kincaid Reservoir[1], 1,290 acres of water

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1. Constructed or under construction.

-Rock Creek Recreation Area, 90 acres of water
-Smoke Rock Creek Recreation Area, 50 acres of water
-Billy Creek Recreation Area, 1 mile of stream
-Cedar Lake Recreation Area, 84 acres of water
-American Lake Recreation Area, 125 acres of water
-Caney Lake Recreation Area, 125 acres of water
-Moon Lake Recreation Area, 200 acres of water

(13) The Soil Conservation Service proposes 22 sponsored multiple-purpose reservoirs, four single-purpose (irrigation or water supply), and 432 single-purpose flood prevention reservoirs in the early-action period. The multiple-purpose reservoirs could offer about 1.2 million recreation days annually with optimum development. Five of these reservoirs have been constructed since this study began. The multiple-purpose reservoir is as follows:

Site	Conservation Pool
CNI-3M2-4[1]	98 acres
CNI-3-68[1]	1,030 acres
CNI-3M2-3[1]	1,220 acres
CNI-3N-2[1]	1,950 acres
CNI-3-70	480 acres
Indian Creek[1]	1,125 acres
CNI-3j-4	87 acres
CNI-3-52	230 acres
CNI-3-57	110 acres
CNI-3M1-7	170 acres
CNI-3-35	100 acres
CNI-3-41	100 acres
CNI-3-23	235 acres
CNI-3i-4	345 acres
CNI-3-19, No. 35	250 acres
CNI-3-19, No. 38	52 acres
CNI-3-25a	340 acres
CNI-3-29	50 acres
CNI-3K-14	300 acres
CNI-3K-11	187 acres

(14) One new reservoir and enlargement of two existing reservoirs are proposed in the preliminary Texas Water Development Plan. The new reservoir has a potential to offer approximately 0.5 million activity occasions annually with initial development. The enlargement programs

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1. Constructed or under construction.

should offer approximately 0.4 million additional activity occasions annually. These projects are as follows:

Reservoir	Conservation Pool
Timber Creek	1,020
Lake O'the Pines (Enlargement)	24,000
Lake Texarkana (Enlargement)	61,750

(15) Tourist information centers should be established at the major points of entrance to the basin to provide information on the recreational opportunities provided in the area. This, of course, should be a program of the States.

(16) In the development of major recreational areas, sufficient sanitary facilities--potable drinking water, waste water disposal and solid waste disposal--will be incorporated to meet the needs of the recreating public.

d. Long-Range Programs

(1) The Corps of Engineers has proposed 14 reservoirs for possible construction during this period. In-depth studies have not progressed at this time wherein specific conclusions or recommendations can be made; however, these projects could offer considerable outdoor recreation opportunity.

(2) The Soil Conservation Service has suggested eight multiple-purpose reservoir sites for construction during this period. Their studies also reveal that approximately 60 single-purpose (recreation, irrigation or municipal and industrial water supply) sites and numerous Public Law 566 flood prevention small watershed structures are feasible for construction and development.

(3) During this period, it is recommended that the initial recreation developments of all early-action multiple-purpose and flood control reservoirs be enlarged to their optimum capacity if the demand is present. This expansion to optimum development could accommodate an additional 10.3 million recreation days annually.

(4) In conjunction with the above enlargements of early-action developments, additional needs must be met for scenic drives, hiking trails, boat access points, highways and access roads, tourist information facilities, and the private service industries.

(5) Chart 3 shows the existing and projected total annual demand, supply, unsatisfied demand, and the percentage of demand satisfied by this plan.

CHART 3

Basin Subarea
Existing and Projected Total Annual Demand, Supply
Unsatisfied Demand, and Percentage of Demand Satisfied
in Activity Occasions (1,000's)

	Boating	Swimming	Camping	Picnicking
1965 Total Annual Demand	4,974	4,162	2,098	6,736
1965 Total Supply	11,180	2,888	430	2,489
1965 Total Annual Unsatisfied Demand	--	1,274	1,668	4,247
Percent of 1965 Demand Satisfied	100	69	21	37
1980 Total Annual Demand	9,180	7,668	3,870	12,416
1980 Total Supply	16,420	11,238	4,698	15,058
1980 Total Annual Unsatisfied Demand	--	--	--	--
Percent of 1980 Demand Satisfied	100	100	100	100
2020 Total Annual Demand	40,774	34,100	17,194	55,190
2020 Total Supply	25,760	24,200	11,784	35,900
2020 Total Annual Unsatisfied Demand	15,014	9,900	5,410	19,290
Percent of 2020 Demand Satisfied	63	71	69	65

(6) Charts 4 and 5 show the estimated capacity of this plan to supply opportunity for outdoor recreation and the facilities needed for this degree of use. Charts 11 and 12 in the supporting data section of this report give the above data by States. The individual project analysis as outlined in this plan was done in terms of the project's ability to offer recreational opportunities. The estimated optimum capacities of the individual sites as shown in Chart 11 are considered to be the site's ability to offer opportunity, not the demand by the public for the site. Consideration was given to location, size of the project, topography, accessibility of the area, competition of other resources, and estimated needs of the area in determining site capacity.

(7) Distribution of the outdoor recreation supply remains a problem in some areas of the basin. The basin as a whole will have adequate public outdoor recreational facilities when this plan is implemented. However, the location of the resource with respect to the population will remain a problem for some areas.

(8) The acreage requirement for general boating has been reduced from 6 acres to 4 acres at some of the proposed reservoirs in this plan. For the increased use of a given water area, such regulatory measures as zoning or policing may be required.

(9) The recreation plan as outlined herein should adequately supply the overall public portion of the general outdoor recreation needs of the basin. One area in which additional planning and development must be undertaken is in the area of offering opportunity to the less fortunate who, due to age, or physical or financial restrictions, may not have the means to utilize most of the facilities included in this plan. Most of these needs can usually be more effectively and efficiently accomplished with developments within or adjacent to residential areas. It is suggested that the planning and development endeavors in this area be increased.

8. SUGGESTED ADMINISTRATIVE AND FUNDING ARRANGEMENTS

a. A partial list of possible cost-sharing arrangements are shown in Chart 6. Federal assistance can be obtained through such legislation and programs as the Watershed Protection and Flood Prevention Act, the Housing and Urban Development Act, the Dingell-Johnson Act, the Pittman-Robertson Act, and the Federal Water Project Recreation Act. The Federal Water Project Recreation Act can also be implemented in projects authorized prior to January 1, 1966.

b. The required scale of recreation development needed throughout the basin makes coordination of all planning and development both necessary and desirable for realization of the potential of the basin's resources.

CHART 4

Red River Basin
Total Estimated Capacity to Offer Outdoor
Recreational Opportunity in Activity Occasions - Average Summer Sunday

State	Boating		Swimming		Camping		Picnicking		Other		Total	
	1980	2020	1980	2020	1980	2020	1980	2020	1980	2020	1980	2020
Arkansas New Projects	11,870	11,675	28,570	13,440	17,885	5,140	30,110	7,340	51,160	23,970	139,595	201,160
Enlargement of Existing Areas	75	50	-	-	600	600	1,200	1,200	1,800	1,800	3,675	7,325
Bank Stabilization and Navigation Project	-	1,800	-	-	-	800	-	2,400	-	2,800	-	7,800
Oklahoma New Projects	19,685	20,160	46,310	39,120	28,360	28,360	48,090	13,280	82,110	80,620	224,555	405,575
Enlargement of Existing Areas	480	240	1,000	900	1,540	950	1,400	440	3,850	2,500	8,270	13,300
Bank Stabilization and Navigation Project	-	1,200	-	-	-	500	-	1,000	-	2,000	-	4,700
Louisiana New Projects	8,165	1,850	20,260	9,930	12,470	6,375	21,095	10,860	36,030	18,650	98,020	145,685
Enlargement of Existing Areas	5,200	-	12,000	-	7,500	-	12,500	-	43,000	-	80,200	80,200
Bank Stabilization and Navigation Project	-	4,000	-	-	-	2,300	-	6,600	-	7,400	-	20,300
Texas New Projects	15,935	66,200	38,420	159,710	23,715	99,320	40,475	167,880	68,930	285,530	187,475	966,115
Enlargement of Existing Areas	8,800	-	39,000	-	26,500	-	26,900	-	64,000	-	165,200	165,200
Enlargement of Caddo, Texarkana, and Lake O'the Pines Reservoirs[1]	-	35,500	-	86,300	-	52,000	-	88,900	-	151,800	-	414,500
Bank Stabilization and Navigation Project	-	1,000	-	-	-	400	-	1,200	-	1,400	-	4,000

1 These facilities include the existing prior to enlargement.

CHART 5

Red River Basin

Total Facilities and Acreages Required to Offer the Estimated Capacity of Outdoor Recreational Opportunity on an Average Summer Sunday

Site	Boating				Swimming		Camping				Picnicking			
	Ramps		Acres		Ac. of Beach		Units		Acres		Tables		Acres	
	1980	2020	1980	2020	1980	2020	1980	2020	1980	2020	1980	2020	1980	2020
Arkansas New Projects	103	98	206	196	56	23	3,577	1,018	3,577	1,018	3,011	734	1,507	368
Enlargement of Existing Areas	1	-	2	-	-	-	120	120	120	120	120	120	60	60
Bank Stabilization and Navigation Projects	-	15	-	30	-	-	-	160	-	160	-	240	-	120
Oklahoma New Projects	164	167	332	334	86	66	6,056	6,018	6,056	6,018	4,805	1,328	2,400	664
Enlargement of Existing Areas	4	2	8	4	2	1	308	190	308	190	140	44	70	22
Bank Stabilization and Navigation Projects	-	10	-	20	-	-	-	100	-	100	-	100	-	50
Louisiana New Projects	69	15	128	30	35	16	2,493	1,267	2,493	1,267	2,110	1,086	980	482
Enlargement of Existing Areas	43	-	86	-	20	-	1,500	-	1,500	-	1,250	-	625	-
Bank Stabilization and Navigation Projects	-	33	-	66	-	-	-	460	-	460	-	660	-	300
Texas New Projects	135	553	270	1,106	67	266	4,749	19,868	4,749	19,868	4,057	16,751	2,030	8,395
Enlargement of Existing Areas	73	-	146	-	65	-	5,300	-	5,300	-	2,690	-	1,345	-
Enlargement of Caddo, Texarkana, and Lake O'the Pines Reservoirs[1]	-	296	-	592	-	144	-	10,400	-	10,400	-	8,900	-	4,445
Bank Stabilization and Navigation Projects	-	8	-	16	-	-	-	80	-	80	-	120	-	120

1. These facilities include the existing prior to enlargement.

CHART 6

RED RIVER BASIN
POSSIBLE ADMINISTRATIVE AND FUNDING ARRANGEMENTS OF RECREATION AREAS UNDER PRESENT LAWS AND REGULATIONS[1]

Construction Agency	Recreation Areas to be Administered by:	Cost-Sharing or Funding of Recreation Development by:
Local organizations (sponsors) under Public Law 566 with assistance from the Soil Conservation Service	Administration of recreation areas at public recreational developments by "local organizations"[2] according to Section 4 of the Watershed Protection and Flood Prevention Act as amended September 27, 1962.	Recreation area development costs and modifications of the project for recreation will be shared by "local organizations"[2] and the Soil Conservation Service according to Section 4 of P.L. 566. Some development may be funded by the Land and Water Conservation Fund Act.[3]
	Privately owned and operated recreation areas administered by landowners.	Recreation area development funded by landowners.
	Administration by U.S. Forest Service when area lies on National forest land.	Recreation area development funded by landowners.
Corps of Engineers	Administration by "Non-Federal public bodies"[4] according to Public Law 89-72 (Federal Water Project Recreation Act) where a cost-sharing and administration agreement has been obtained, unless considered appropriate for Federal administration.	Funded as project cost but cost shared by non-Federal public bodies as set forth in Public Law 89-72 (Federal Water Project Recreation Act) where a cost-sharing and administration agreement has been obtained.
	Administration by the U.S. Forest Service under terms of Aug. 13, 1964, memorandum of agreement between the Sec. of the Army and the Sec. of Agriculture of those project areas appropriate for administration by the U.S.F.S. as part of a National forest system.	Recreation area development funded by the U.S. Forest Service.
	Administration of recreation areas at completed projects will be by the Corps of Engineers or other agencies in accordance with the policy prevailing at each project. Present policy provides that recreation areas may be administered by the Corps or leased to non-Federal agencies for such administration.	Existing recreation areas will be funded by the administering agency. Further development of Corps administered areas will be with Code 710 funds, subject to present policy which provides that cost-sharing provisions of P.L. 89-72 will be applicable after 30 June 1976 at projects completed before or during FY 1966 and after 30 June 1980 at projects under construction before or during FY 1966. All development of new areas not developed at completed projects by FY 1966 nor included in the initial construction will require cost-sharing in accordance with provisions of P.L. 89-72.
State Authorized[5] Conservation or Development District or Authority	Administration of recreation areas by the authorized district or authority, or by State or local agencies.	Funding by State or local agencies with cost-sharing under provision of Land and Water Conservation Fund Act of 1965.
		Funding by authorized district or authority cost-sharing under provisions of Land & Water Conservation Fund Act 1965.
	Administration of recreation areas by the U.S. Forest Service on National forest land.	Recreation area development funded by the U.S. Forest Service.
U.S. Forest Service	Administration of recreation areas by the U.S. Forest Service on National forest land.	Recreation area development funded by the U.S. Forest Service.
		Land acquisition may be financed by the Land & Water Conservation Fund Act 1965, (P.L. 88-578) and the Weeks Law of 1911.
State Agencies	State Park System Park and Recreation Development	Funding by State Park System with cost-sharing under provisions of the Land and Water Conservation Fund Act 1965 and Housing and Development Act of 1965.
	State Game and Fish Commission	Funding for fishing areas could be under provisions of the Dingell-Johnson Act. Funding for hunting areas could be under provisions of the Pittman-Robertson Act. State funds may also be used for both types of areas.
Local Governmental bodies	The administration by local Governmental bodies.	Funding by local Governmental bodies with cost-sharing under provisions of the Land & Water Conservation Fund Act of 1965 and the Housing and Development Act of 1965.

1. Partial list of existing laws and regulations.

2. Any State, political subdivision thereof, soil or water conservation district, flood prevention or control district, or combinations thereof, or any other agency having authority under State law to carryout, maintain and operate the works of improvement; or any irrigation or reservoir company, water users' association, or similar organization having such authority and not being operated for profit.

3. Expansion of initial recreational areas; additional lands may be acquired and/or developed; development of such projects as swimming pools, golf courses, and group campgrounds which are not eligible for small watershed assistance are eligible under the Land and Water Conservation Fund Program.

4. Non-Federal public bodies--public entities such as States, counties, municipalities, recreation districts or other special-purpose districts with sufficient authority to participate under the provisions of the bill.

5. Such State authorized agencies as a River Authority or Recreation District.

SECTION V - EVALUATION

1. BENEFITS

a. Tangible Benefits

(1) In order to estimate the recreation benefits that would be derived from the proposed early-action projects, the number of recreation days that could be accommodated at each project was determined. A value of a recreation day was then assigned. This was based on the location of the project with respect to population, alternative recreation areas, facilities to be provided, and other factors. Recreation day values ranged from $0.50 to $1.50.

(2) (a) For the proposed Corps of Engineers early-action reservoir projects, the value of recreation days with various scales of development are as follows:

Reservoir	Minimum Facilities for Health and Safety 1980	Initial Development 1980	Optimum Development 2020
Kisatchie	$0.50	$1.00	$1.50
Dorcheat	0.50	1.00	1.50
Parker	0.50	0.75	1.00
Bonham	0.50	0.75	1.00
Albany	0.50	0.75	1.00
Durant	0.50	0.75	1.00
Liberty Hill	0.50	0.75	1.00
Sherwood	0.50	0.75	1.00
Caddo Lake (Enlargement)	0.50	0.75	1.00

Notes: (1) Values assigned above include those assigned to "incidental fishing" but not values for "hard core" fishing. Such values would be in addition to the above.

(2) In assigning values it was assumed that fluctuations at all nonpower reservoirs would be held to a minimum during the recreation season.

(3) Over 18 million recreation days annually can be accommodated by the early-action plan. Although this plan is programmed for construction by 1980, a more realistic operational date would be 1990. This will require staging of the development program and

benefits received. The estimated annual benefits of the early-action recreation plan is $18 million.

(4) Benefits from flow augmentation in three multiple-purpose reservoirs were evaluated by the Use Method and computed on the basis of the greatest benefit to an individual use. Benefits for fish and wildlife were evaluated by the Bureau of Sport Fisheries and Wildlife, and recreation benefits were evaluated by the Bureau of Outdoor Recreation, in coordination with the Federal Water Pollution Control Administration. No tangible benefits were assigned to aesthetics. The annual values of storage for water quality control, based on the greatest benefit to an individual use, are presented in the following tabulation:

Reservoir Project		Benefits ($) Fish and Wildlife	Recreation	Total
Corps of Engineers:				
Bayou Dorcheat	Bayou Dorcheat, Ark-La.	13,000[1]	147,000[1]	160,000[1]
	Bodcau Bayou, La.	4,000	103,000	107,000
	Total	17,000	250,000	267,000
Soil Conservation Service:				
W'shed. 3m1-7	Big Creek, Ark.	500	15,000	15,500
	Bayou Dorcheat, Ark-La.	13,000[1]	147,000[1]	160,000[1]
	Total	13,500	162,000	175,500
W'shed. 3-23	Mineral Bayou, Okla.	800	400	1,200

(5) Other proposals in the recreation plan will provide facilities to accommodate more recreation days of outdoor activity. These are the free-flowing streams, scenic areas, special areas and complexes, boat access areas, scenic trails, and hiking and saddle trails. Recreation day capacity and monetary benefits were not determined for these projects.

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1. By the joint CE-SCS plan, initial needs in Bayou Dorcheat to be supplied by storage in the SCS project.

b. Intangible Benefits

(1) Other investments may well achieve monetary returns comparable with or in excess of these expected from investments proposed in this recreation plan. The real value of much of this plan lies in the realm of intangible benefits. It is in this realm that investments in recreation often obtain more merit than other types of investments.

(2) The development of land and water resources in this Nation is essential to produce material benefits. However, material wealth is not the sum total of our existence and the "Gross National Product" does not measure all of our needs and desires. Material things alone do not provide a satisfactory and complete life for all people. The quality of our existence includes the diversity and preservation of beauty and does not permit a total emphasis on the use of our resources to produce material wealth. The need for preserving unspoiled nature is related to the satisfaction of our spiritual and social needs.

(3) The preservation of free-flowing streams will help fill the need for a greater variety of recreation opportunities in the Red River Basin. It will also fill the need for higher quality recreation, with "quality" defined as the degree to which the recreation experience differs from the ordinary - also the degree to which it stirs our higher senses, our feelings about the beauty of the natural world.

(4) Preservation of such unique areas as Grassy Lake, Fulton, Arkansas, an additional segment of the Current River, and other selected areas and streams will help satisfy a need for the enjoyment of nature. Likewise, the establishment of scenic areas, special areas and complexes, and hiking and saddle trails all help fill the need for people to remove themselves from the fast pace of everyday living and to enjoy a natural environment.

2. COST

The total cost of the multiple-purpose structures proposed in the early-action recreation plan is approximately $390 million. The cost of these projects allotted to recreation, including recreation facilities to be constructed, is approximately $28 million.

3. COMPARISON OF BENEFITS AND COSTS

a. Comparison of benefits and costs for the multiple-purpose Soil Conservation Service reservoirs is covered in the summary report and in Appendix V.

b. Comparison of benefits and costs for the multiple-purpose Corps of Engineers reservoirs is given in Appendix XV.

4. COST ALLOCATIONS, COST SHARING, AND REIMBURSEMENTS

Cost allocations and reimbursements are discussed in the summary report. Cost sharing for recreation development was previously discussed in Part IV of this report in the section on "SUGGESTED ADMINISTRATIVE AND FUNDING ARRANGEMENTS."

5. LEAST COST ALTERNATIVE

Some of the needs of the recreation market area for facilities for swimming, picnicking, camping, and hiking could be met through the expansion of existing recreation areas and the construction of new areas. The cost of providing these extra facilities may be approximately the same as it would be to provide those facilities at the proposed early-action multiple-purpose reservoirs. However, in the case of water-dependent recreation activities, there will be a shortage of water acreage in the basin after 1980 which would necessitate the construction of reservoirs to reduce the unsatisfied demand for boating and swimming.

SECTION VI - COORDINATION WITH OTHER INTERESTS

The preparation of this appendix was fully coordinated with interested State and Federal agencies. It was prepared by the Bureau of Outdoor Recreation as the chairing agency of the ad hoc Recreation Work Group Committee. The information and data herein were supplied, developed, and coordinated by the representatives of the following agencies as members of the above committee.

1. Oklahoma Industrial Development and Parks Commission

2. Louisiana
   a. State Parks and Recreation Commission
   b. Department of Public Works

3. Arkansas
   a. Planning Commission
   b. Soil and Water Conservation Commission

4. Texas
   a. Department of Parks and Wildlife
   b. Water Development Board

5. Department of the Army
   a. Engineer District, New Orleans
   b. Engineer District, Tulsa

6. Department of the Interior
   a. Bureau of Outdoor Recreation
   b. Bureau of Sport Fisheries and Wildlife
   c. Federal Water Pollution Control Administration
   d. National Park Service

7. Federal Power Commission

8. Department of Health, Education, and Welfare

9. Department of Agriculture
   a. Economic Research Service
   b. Soil Conservation Service
   c. U.S. Forest Service

Swimming beach at Lake Texarkana

SECTION VII - CONCLUSIONS

As a result of this study, the following conclusions are drawn:

1. Existing public lands, waters, and recreational areas are not developed to the extent of their capability to offer outdoor recreational opportunities. Recreation access (roads, land and facilities) to the basin's major streams and lakes, natural or manmade, is inadequate and the need will increase in the future. Also, existing facilities are poorly distributed. A major portion of the present unsatisfied outdoor recreation demand could be effectively and efficiently satisfied with proper development of existing resources.

2. Vast areas of the basin's ecosystem are being altered as a result of clearing and drainage, and stream flow alterations. Projects have been based on short-term planning and research without consideration of the lasting effects and overall impact of such alterations.

3. Water quality is of utmost importance both for the enjoyment of outdoor recreation and for the protection of the public health. The basin States have established acceptable water quality standards. Enforcement of these standards will be a most important task.

4. The population of the recreation market area will continue to increase as will the per capita personal income. The percent of the total population which is urban will also increase. All these factors will contribute to increasing outdoor recreation demand. Compounded with the decreasing availability of water and related land resources, the result will be increasing demands upon the existing and programmed supply of outdoor recreation opportunity.

5. The physiographic and topographic features in the upper mountainous portion of the basin give this area a variety of resources for water-based outdoor recreation development, while the southern portion, due to relatively flat topography, is limited in its ability to supply reservoirs for general boating and water skiing. Residents of the more densely populated southern portion of the basin must journey upstream if they desire an abundance of water-related recreation.

6. Land-use management programs are a definite need in the basin. Land-use controls such as easements, zoning, and rights-of-way could insure the protection, enhancement, and development of the diminishing recreational resources.

In lieu of fee simple acquisition, easements could be used for scenic belts and protection zones. Zoning ordinances which permit cluster type home development would encourage open spaces for park and recreational development. Flood plain zoning would preserve bottomland resources and could eliminate a need for expensive water control projects. Rights-of-way corridors for routing power and pipelines would reduce damage of the natural beauty of an area. State and local governments need to review existing laws to determine if revisions or the adoption of new statutes are needed. Also a periodic review of existing policies governing water quality, game and fish management, planning programs, and taxation will help insure proper development and utilization of their recreational resources.

7. The scale of recreation development needed to satisfy present and future demands requires Federal, State, and local agencies to coordinate all planning and development activities. This coordination should be directed by the respective State outdoor recreation planning staff. The official State comprehensive outdoor recreation plan should be the focal point for all planning and development activities.

8. The respective States need to implement programs for the preservation of their more unique streams and ecological, geological and botanical areas. These programs should be incorporated into the State comprehensive outdoor recreation plan and be supported by legislative authority.

9. Additional city or urban parks and recreational areas are needed for most cities or towns in the basin. These parks or recreational areas need to be located within or as close to residential areas as possible.

10. The outdoor recreation plan as outlined in this appendix is in accord with the respective States' comprehensive outdoor recreation plans. However, the degree to which each State will be able to participate in the implementation will be determined at a later time on a project-by-project basis.

11. The net effect of this recreation plan on fish and wildlife will be favorable. While the supply of fishing waters will be increased, the supply of upland game hunting will be decreased due to the reduction in acreage of bottomland hardwood habitat. This loss will be partially offset by the increased opportunities for hunting adjacent to the proposed reservoirs.

SECTION VIII - IMPLEMENTATION

The findings of this study are:

1. Existing under-developed recreation areas should be expanded in quality and quantity of facilities. Much of the 1980 needs could be satisfied with proper development of existing areas. Also, additional access areas to the basin's major streams, lakes, and land areas should be provided to utilize these existing outdoor recreation resources.

2. The respective States should implement an environmental preservation program based on ecological planning and legislative action to preserve some of their unique streams, geological, and/or botanical areas.

a. The following streams are suggested for preservation:

Louisiana

- Saline Bayou in Bienville, Winn, and Natchitoches Parishes, 60 miles of stream.
- Bayou Bodcau from Arkansas-Louisiana line to existing damsite in Louisiana, 40 miles of stream.
- Bayou Dorcheat above Lake Bistineau, 40 miles of stream.
- Black Lake Bayou above Black Lake, 70 miles of stream.

Arkansas

- Mountain Fork River, from Oklahoma State line, 15 miles of stream.
- Upper Cossatot River, upstream from Gillham Lake, 60 miles of stream.
- Upper Little River, upstream from Millwood Reservoir, 20 miles of stream.
- Bayou Bodcau above Lake Erling, 17 miles of stream.
- Bayou Dorcheat above and below proposed Dorcheat Reservoir, 15 miles of stream.
- Saline River above Dierks Reservoir, 25 miles of stream.

Oklahoma

- Muddy Boggy Creek from its mouth on Red River upstream to near Unger, Oklahoma, 16 miles of stream.
- Kiamichi River from its mouth on Red River upstream to near Sawyer, Oklahoma, 20 miles of stream.
- Rolling Fork River above DeQueen Reservoir, 25 miles of stream.

- Blue River from near Milburn, Oklahoma, upstream for 20 miles of stream.
- Little River from Pine Creek dam downstream to the Arkansas state line, for a total of 71 miles of stream.
- Mountain Fork River from Broken Bow reregulating dam downstream to the Little River junction, a distance of 11 miles of stream.
- Glover Creek from State Highway No. 3 downstream to its confluence with Little River for a distance of 10 miles of stream.
- Kiamichi River from near Tuskahoma downstream to near Antlers, 29 miles of stream.
- Black Fork Creek from its junction with Little River upstream for 21 miles.
- Little River from near Honobia downstream to the upper end of Pine Creek Reservoir for a distance of 47 miles of stream.

b. The following unique and/or scenic areas should be preserved, at least in part, for future use and enjoyment:

(a) The Shut-ins area on the upper Cossatot River, Arkansas;
(b) Grassy Lake in Hempstead County, Arkansas;
(c) The "Skyline Drive" area of southeastern Oklahoma;
(d) The Beaver Bend State Park area, Oklahoma; and
(e) The "Backwater" area at the confluence of the Red and Mississippi Rivers.

3. The respective States should review their existing laws to determine if revisions are needed to implement land-use management programs and to insure proper development and utilization of recreational resources. Emphasis should be directed towards possible utilization of zoning ordinances, easements, and other land-use controls.

4. The respective States should diligently enforce their established water quality standards which will guarantee a quality water-oriented recreational resource and the public health and welfare of its users. Stretches of streams designated for recreational use and preservation should be classified and maintained with quality suitable for contact recreational activities.

5. Coordination between all State, Federal, and local outdoor recreation agencies should be delineated and implemented through the respective State Comprehensive Outdoor Recreation Planning process.

6. The respective State and local governments should review existing policies and programs related to outdoor recreation in order to clarify areas of responsibility to better promote coordinated development of the basin's recreational resources.

7. The cities and towns of the basin should develop and maintain sufficient city-park type recreation areas to satisfy existing and estimated future urban needs.

8. The following multiple-purpose reservoirs of the early-action recreation plan should be developed with outdoor recreation facilities to the degree feasible to utilize their resources and meet the needs of the area.

a. Corps of Engineers reservoirs completed or under construction since January 1, 1963:

Reservoir	Conservation Pool
Millwood	24,500 acres
DeQueen	1,680 acres
Dierks	1,360 acres
Gillham	1,370 acres
Broken Bow	14,200 acres
Pine Creek	3,800 acres
Hugo	13,250 acres
Pat Mayse	5,993 acres

b. Corps of Engineers Reservoirs authorized for construction:

Reservoir	Conservation Pool
Cooper	19,270 acres
Big Pine	4,640 acres
Clayton	8,900 acres
Tuskahoma	11,600 acres
Lukfata	1,100 acres
Boswell	5,540 acres

c. Soil Conservation Service small watershed reservoirs completed or under construction since January 1, 1963:

Site	Conservation Pool
CNI-3-68	1,030 acres
CNI-3M2-3	1,220 acres
CNI-3N-2	1,950 acres
Indian Creek	1,125 acres

9. The following proposed multiple-purpose reservoirs should include recreation as a project purpose and be developed for recreational use to meet the needs of the area.

a. Corps of Engineers

Reservoir	Conservation Pool
Kisatchie	9,190 acres
Dorcheat	13,300 acres
Parker	6,170 acres
Bonham	5,280 acres
Albany	4,960 acres
Durant	8,980 acres
Liberty Hill	7,070 acres
Sherwood	30,740 acres
Caddo Lake Enlargement	27,000 to 35,600 acres

b. Soil Conservation Service

	Conservation Pool
CNI-3-57A	60 acres
CNI-3M2-4	98 acres
CNI-3-70	480 acres
CNI-3j-4	87 acres
CNI-3-52	230 acres
CNI-3-57	110 acres
CNI-3M1-7	170 acres
CNI-3-35	100 acres
CNI-3-41	100 acres
CNI-3-23	235 acres
CNI-3i-4	345 acres
CNI-3-19, No. 35	250 acres
CNI-3-19, No. 38	52 acres
CNI-3-25a	340 acres
CNI-3-29	50 acres
CNI-3K-14	300 acres
CNI-3K-11	187 acres

c. Texas Water Development Board (Preliminary Plan)

Reservoir	Conservation Pool
Timber Creek	1,020
Lake O'the Pines (Enlargement)	24,000
Lake Texarkana (Enlargement)	61,750

10. The following outdoor recreation areas should be constructed on U.S. Forest Service lands during the early-action period.

-Dogwood Recreation Area
-Livingston Recreation Area

-Stuart Lake, 3 acres of water
-Kincaid Reservoir, 1,290 acres of water
-Rock Creek Recreation Area, 90 acres of water
-Smoke Rock Creek Recreation Area, 50 acres of water
-Billy Creek Recreation Area, 1 mile of stream
-Cedar Lake Recreation Area, 84 acres of water
-American Lake Recreation Area, 125 acres of water
-Caney Lake Recreation Area, 125 acres of water
-Moon Lake Recreation Area, 200 acres of water

11. The bank stabilization and navigation project of the Corps of Engineers on the Red River main stem and tributaries should include recreation as a project purpose with the development of the 45 proposed access sites.

12. Land acquisition for recreational development at public works projects should include sufficient land to allow for long-range expansion to meet the projected 2020 needs.

13. All recreational developments meet State Public Health standards.

14. Recreation be studied as a purpose in all future public works project formulations, including interstate highways and airports.

15. The enhancement, protection, and improvement of the fish and wildlife resources should be pursued in a manner that will complement their importance to the total outdoor recreation resource in the basin.

Waterskiing on Lake O' the Pines

SECTION IX - SUPPORTING DATA SECTION

1. Charts 7 show the existing and projected population and per capita personal income for the respective States. These data were converted to total annual, summer, and average summer Sunday demand by multiplying by the respective participation per $1,000.

2. Charts 8 show the known existing public outdoor recreation areas for the respective States.

3. Chart 9 shows known existing recreation facilities and programmed improvements by 1970.

4. Charts 10 show the existing and projected average summer Sunday demand, supply, and needs (needs expressed in facilities) for the basin and the respective States.

5. Chart 11 shows capacity and monetary benefits of proposed Corps of Engineers early-action reservoirs.

6. Charts 12 show the estimated capacity of the individual projects to offer outdoor recreational opportunity in activity occasions on an average summer Sunday.

7. Charts 13 show the facilities and land acreages needed for the individual site to offer optimum outdoor recreational opportunities on an average summer Sunday.

8. Chart 14 shows the individual State's and the total basin's acreages of public wetland, land, and water.

9. Chart 15 shows a comparison by percentages of developed recreation land, annual attendance and population of the basin States.

CHART 7

Louisiana Subarea
Existing and Projected Population and Per Capita Personal Income

Area	1965 Population (1,000)	1965 Per Capita Personal Income	Population x PCPI (1,000)	1980 Population (1,000)	1980 Per Capita Personal Income	Population x PCPI (1,000)	2020 Population (1,000)	2020 Per Capita Personal Income	Population x PCPI (1,000)
Louisiana Subarea									
15 Parishes	512.0	1,600	820,000	667.8	2,320	1,550,000	1,203.0	5,990	7,200,000
3 Shared Parishes[1]	14.6	1,600	23,000	16.9	2,320	39,000	28.3	5,990	170,000
Shreveport SMSA[2]	273.0	2,100	573,000	355.5	2,900	1,030,000	765.0	6,500	4,970,000
Monroe SMSA[3]	12.1	1,900	23,000	17.0	2,500	42,000	37.8	5,700	215,000
Baton Rouge SMSA[4]	12.5	2,500	31,000	20.0	3,600	72,000	45.0	8,000	360,000
Lake Charles SMSA[5]	7.8	2,500	19,000	10.7	3,400	36,000	22.9	8,000	183,000
Total	832.0		1,489,000	1,087.9		2,769,000	2,100.0		13,098,000

Louisiana Subarea
Existing and Projected Total Annual, Summer, and Average Summer Sunday Demand
in Activity Occasions - Red River Basin below Denison Dam

Activity	Average Summer Sunday Participation Rate Per ($1,000)	Average Summer Sunday Demand in Activity Occasions (1,000) 1965	1980	2020	Total Summer Participation Rate Per ($1,000)	Total Summer Demand in Activity Occasions (1,000) 1965	1980	2020	Total Annual Participation Rate Per ($1,000)	Total Annual Demand in Activity Occasions (1,000) 1965	1980	2020
Boating	0.0226	33.6	62.6	296.0	0.730	1,086.0	2,021.0	9,560.0	1.470	2,188.0	4,070.0	19,254.0
Swimming	0.0270	40.2	74.7	353.0	0.880	1,310.0	2,436.0	11,526.0	1.230	1,830.0	3,400.0	16,110.0
Camping	0.0170	25.3	47.0	222.0	0.300	446.0	830.0	3,930.0	0.620	923.0	1,720.0	8,120.0
Picnicking	0.0280	41.7	77.5	366.0	0.930	1,385.0	2,575.0	12,180.0	1.990	2,963.0	5,510.0	26,065.0
Subtotal		140.8	261.8	1,237.0		4,227.0	7,862.0	37,196.0		7,904.0	14,700.0	69,549.0
Other Activities												
Playing Games	0.0050	7.4	13.8	65.0	0.192	286.0	532.0	2,515.0	0.840	1,250.0	2,325.0	11,000.0
Fishing (Inc.)	0.0030	4.4	8.3	39.0	0.112	167.0	310.0	1,467.0	0.270	400.0	747.0	3,536.0
Sightseeing	0.0280	41.7	77.5	366.0	0.915	1,362.0	2,534.0	11,985.0	2.950	4,393.0	8,168.0	38,640.0
Hiking	0.0030	4.4	8.3	39.0	0.103	153.0	285.0	1,349.0	0.210	313.0	580.0	2,750.0
Nature Walks	0.0080	11.9	22.0	104.0	0.287	427.0	795.0	3,759.0	1.430	2,129.0	3,960.0	18,730.0
Subtotal		69.8	129.0	613.0		2,395.0	4,456.0	21,075.0		8,485.0	15,780.0	74,656.0
Total		210.6	391.7	1,850.0		6,622.0	12,318.0	58,271.0		16,389.0	30,480.0	144,200.0

1. DeSoto, Sabine, and Vernon Parishes are shared with the Sabine River report due to squaring off the two basins on county lines rather than basin drainage. The percentage of the Parish population used in the Red River report are: DeSoto 40%, Sabine 10%, and Vernon 10%.
2. Shreveport SMSA - 90% of the population.
3. Monroe SMSA - 11% of the population.
4. Baton Rouge SMSA - 5% of the population.
5. Lake Charles SMSA - 5% of the population.
6. Population x PCPI x Participation Rate = Demand in Activity Occasions.

CHART 7

Arkansas Subarea
Existing and Projected Population and Per Capita Personal Income

Area	1965 Population (1,000)	1965 Per Capita Personal Income	Population x PCPI (1,000)	1980 Population (1,000)	1980 Per Capita Personal Income	Population x PCPI (1,000)	2020 Population (1,000)	2020 Per Capita Personal Income	Population x PCPI (1,000)
9 Counties	153.0	1,450	222,000	186.1	2,085	388,000	321.5	5,600	1,800,000
Fort Smith SMSA	3.6	2,000	7,200	5.8	2,700	15,600	7.5	6,400	48,000
5% of Population Participating in Basin									
Total	156.6		229,200	191.9		403,600	329.0		1,848,000

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Arkansas Subarea
Existing and Projected Total Annual, Summer and Average Summer Sunday Demand in Activity Occasions - Red River Basin below Denison Dam

Activity	Average Summer Sunday Participation Rate Per ($1,000)	Average Summer Sunday Demand in Activity Occasions (1,000) 1965	1980	2020	Total Summer Participation Rate Per ($1,000)	Total Summer Demand in Activity Occasions (1,000) 1965	1980	2020	Total Annual Participation Rate Per ($1,000)	Total Annual Demand in Activity Occasions (1,000) 1965	1980	2020
Boating	0.0226	5.2	9.1	42.0	0.730	167	294	1,349	1.470	336	593	2,716
Swimming	0.0270	6.2	10.9	50.0	0.880	202	355	1,626	1.230	282	496	2,273
Camping	0.0170	3.8	6.8	31.4	0.300	68	121	554	0.620	142	250	1,145
Picnicking	0.0280	6.4	11.3	51.7	0.930	213	375	1,718	1.990	456	803	3,677
Subtotal		21.6	38.1	175.1		650	1,145	5,247		1,216	2,142	9,811
Other Activities												
Playing Games	0.0050	1.1	2.0	9.2	0.192	44	77	355	0.840	192	339	1,552
Fishing (Inc.)	0.0030	0.7	1.2	5.5	0.112	25	45	207	0.270	62	109	498
Sightseeing	0.0280	6.4	11.3	51.7	0.915	209	369	1,690	2.950	676	1,190	5,451
Hiking	0.0030	0.7	1.2	5.5	0.103	24	41	190	0.210	48	85	388
Nature Walks	0.0080	1.8	3.2	14.7	0.287	65	115	530	1.430	327	577	2,642
Subtotal		10.7	18.9	86.6		367	647	2,972		1,305	2,300	10,531
Total		32.3	57.0	261.7		1,018	1,792	8,219		2,521	4,442	20,342

CHART 7

Oklahoma Subarea
Existing and Projected Population and Per Capita Personal Income

Area	1965 Population (1,000)	1965 Per Capita Personal Income	Population x PCPI (1,000)	1980 Population (1,000)	1980 Per Capita Personal Income	Population x PCPI (1,000)	2020 Population (1,000)	2020 Per Capita Personal Income	Population x PCPI (1,000)
Oklahoma Subarea	232.6	1,400	325,600	254.1	2,000	508,000	326.0	5,500	1,793,000
Oklahoma City SMSA - 10% of Population Participating in Basin	55.4	2,100	116,300	80.8	2,900	234,000	176.0	7,000	1,232,000
Total	288.0		441,900	334.9		742,000	502.0		3,025,000

Oklahoma Subarea
Existing and Projected Total Annual, Summer, and Average Summer Sunday Demand in Activity Occasions - Red River Basin below Denison Dam

Activity	Average Summer Sunday Participation Rate Per ($1,000)	Average Summer Sunday Demand in Activity Occasions (1,000) 1965	1980	2020	Total Summer Participation Rate Per ($1,000)	Total Summer Demand in Activity Occasions (1,000) 1965	1980	2020	Total Annual Participation Rate Per ($1,000)	Total Annual Demand in Activity Occasions (1,000) 1965	1980	2020
Boating	0.0226	9.9	16.7	68.0	0.730	323.0	542.0	2,200.0	1.470	650.0	1,100.0	4,450.0
Swimming	0.0270	11.9	20.0	82.0	0.880	390.0	652.0	2,660.0	1.230	544.0	912.0	3,720.0
Camping	0.0170	7.5	12.6	51.0	0.300	132.0	222.0	907.0	0.620	274.0	460.0	1,875.0
Picnicking	0.0280	12.3	21.0	85.0	0.930	410.0	690.0	2,813.0	1.990	880.0	1,476.0	6,019.0
Subtotal		41.6	70.3	286.0		1,255.0	2,106.0	8,580.0		2,348.0	3,948.0	17,064.0
Other Activities												
Playing Games	0.0050	2.0	3.7	15.0	0.192	85.0	142.0	580.0	0.840	371.0	623.0	2,540.0
Fishing (Inc.)	0.0030	1.3	2.0	9.0	0.112	49.0	83.0	339.0	0.270	119.0	200.0	817.0
Sightseeing	0.0280	12.3	21.0	85.0	0.915	404.0	679.0	2,768.0	2.950	1,300.0	2,189.0	8,924.0
Hiking	0.0030	1.3	2.0	9.0	0.103	46.0	76.0	312.0	0.210	93.0	156.0	635.0
Nature Walks	0.0080	3.5	6.0	24.0	0.287	127.0	213.0	868.0	1.430	632.0	1,060.0	4,326.0
Subtotal		20.4	34.7	142.0		711.0	1,193.0	4,867.0		2,515.0	4,228.0	17,242.0
Total		62.0	105.0	428.0		1,966.0	3,299.0	13,447.0		4,863.0	8,176.0	34,306.0

CHART 7

Texas Subarea
Existing and Projected Population and Per Capita Personal Income

Area	1965 Population (1,000)	1965 Per Capita Personal Income	Population x PCPI (1,000)	1980 Population (1,000)	1980 Per Capita Personal Income	Population x PCPI (1,000)	2020 Population (1,000)	2020 Per Capita Personal Income	Population x PCPI (1,000)
13 Basin Counties	385.0	1,680	646,800	452.0	2,360	1,066,000	706.0	6,000	4,236,000
6 Shared Counties[1]	63.5	1,680	106,700	72.0	2,360	170,000	115.0	6,000	690,000
Dallas SMSA[2]	116.5	2,900	337,800	204.0	4,000	816,000	396.0	8,200	3,247,000
Fort Worth SMSA[3]	31.0	2,600	80,600	44.0	3,700	163,000	110.0	7,800	858,000
Tyler SMSA[4]	25.2	2,100	52,900	38.0	2,900	110,000	108.0	6,800	734,000
Total	621.2		1,224,800	810.0		2,325,000	1,435.0		9,765,000

Texas Subarea
Existing and Projected Total Annual, Summer, and Average Summer Sunday Demand
in Activity Occasions - Red River Basin below Denison Dam

Activity	Average Summer Sunday Participation Rate Per ($1,000)	Average Summer Sunday Demand in Activity Occasions (1,000) 1965	1980	2020	Total Summer Participation Rate Per ($1,000)	Total Summer Demand in Activity Occasions (1,000) 1965	1980	2020	Total Annual Participation Rate Per ($1,000)	Total Annual Demand in Activity Occasions (1,000) 1965	1980	2020
Boating	0.0226	27.6	52.5	220.0	0.730	894.0	1,697.0	7,128.0	1.470	1,800.0	3,417.0	14,354
Swimming	0.0270	33.0	62.7	264.0	0.880	1,077.0	2,046.0	8,593.0	1.230	1,506.0	2,860.0	12,000
Camping	0.0170	20.8	39.5	166.0	0.300	367.0	697.0	2,929.0	0.620	759.0	1,440.0	6,054
Picnicking	0.0280	34.0	65.0	273.0	0.930	1,139.0	2,162.0	9,080.0	1.990	2,437.0	4,627.0	19,430.
Subtotal		115.4	219.7	923.0		3,477.0	6,602.0	27,730.0		6,502.0	12,344.0	51,838
Other Activities												
Playing Games	0.0050	6.1	11.6	49.0	0.192	235.0	446.0	1,874.0	0.840	1,028.0	1,953.0	8,200
Fishing (Inc.)	0.0030	3.7	6.9	29.0	0.112	137.0	260.0	1,093.0	0.270	330.0	628.0	2,636.
Sightseeing	0.0280	34.0	65.0	273.0	0.915	1,120.0	22,127.0	8,935.0	2.950	3,613.0	5,858.0	28,800.
Hiking	0.0030	3.7	6.9	29.0	0.103	126.0	239.0	1,000.0	0.210	257.0	488.0	2,050.
Nature Walks	0.0080	9.8	18.6	78.0	0.287	352.0	667.0	2,800.0	1.430	1,750.0	3,324.0	13,960
Subtotal		57.3	109.0	458.0		1,970.0	3,739.0	15,702.0		6,978.0	13,251.0	55,646
Total		172.7	328.7	1,381.0		5,447.0	10,341.0	43,432.0		13,480.0	25,595.0	107,484

1. Hunt, Hopkins, Wood, Upshur, Gregg, Harrison and Panola Counties are shared with the Sabine River report due to the squaring of the basin on county lines rather than the drainage boundary. The percentage of the population of these counties used in the Red River report are as follows: Hunt 20%, Hopkins 80%, Wood 10%, Upshur 50%, Gregg 50%, Harrison 50%, and Panola 10%.
2. Dallas SMSA - 10% of the population
3. Fort Worth SMSA - 5% of the population
4. Tyler SMSA - 27% of the population

CHART 8
Red River Basin
Acreages Classification and Attendance for Recreation Areas

Area (Louisiana)	Land	Wetland	Water	Total	Class I[1]	Class II[1]	Class III[1]	Class IV[1]	Class V[1]	Class VI[1]	Acres Developed Recreation Area	Reported Day Visits	Attendance Overnight
Kepler Lake	40	-	1,925	1,965	10	30	1,925	-	-	-	7	27,375	18,250
Bodcau Game Management Area	26,400	6,000	600	33,000	-	-	33,000	-	-	-	65	330,000	1,000
Kisatchie Ntl. Forest (Clair Co.)	16,692	-	2,300	18,992	-	3,030	15,962	-	-	-	11	69,000	2,000
Wallace Lake Reservoir	463	-	2,300	2,763	-	2,763	-	-	-	-	6	19,596	400
Fair Park H.S.	25	-	-	25	-	25	-	-	-	-	15	N/A	-
Byrd H.S.	35	-	-	35	-	35	-	-	-	-	20	N/A	-
Caddo Levee Dist.	6,200	1,500	2,600	10,300	-	3,000	7,300	-	-	-	150	40,000	6,000
Caddo Lake	-	-	13,200	13,200	-	-	13,200	-	-	-	-	-	-
Soda Lake Game Mgt. Area	600	-	-	600	-	-	600	-	-	-	-	1,000	-
Woodlawn H.S.	40	-	-	40	-	40	-	-	-	-	25	N/A	-
Catahoula Game Mgt. Area	40,000	-	-	40,000	-	-	40,000	-	-	-	-	20,000	-
Kisatchie Nt. Forest (Grant Co.)	112,206	-	2,006	114,212	-	34	114,098	80	-	-	84	37,000	-
Red Dirt Game Mgt. Area	38,000	-	2	38,002	-	-	38,002	-	-	-	-	20,000	-
Kisatchie Nt. Forest (Natch. Co.)	124,937	-	2,013	126,950	-	365	126,165	420	-	-	17	33,000	9,000
Evangeline Game Mgt. Area	15,000	-	-	15,000	-	-	15,000	-	-	-	-	7,000	
Fort Buhlow Lake	75	-	365	440	365	50	10	-	5	10	430	109,500	
Alexandria State Area	7,750	280	80	8,110	-	50	8,060	-	-	-	150	5,000	500
Kisatchie Nt. Forest (Rapides Co.)	99,165	200	2,178	101,543	-	477	100,976	90	-	-	46	160,000	11,000
Lake Bistineau St. Pk.	950	-	-	950	-	300	650	-	-	-	68	252,957	-
Lake Bistineau	-	-	17,200	17,200	-	-	17,200	-	-	-	-	-	-
Kisatchie Nt. Forest (Webster Co.)	11,548	-	610	12,158	-	1,812	10,346	-	-	-	157	125,000	6,000
Earl Long Memorial Pk.	1	-	-	1	1	-	-	-	-	-	1	N/A	-
Kisatchie Nt. Forest (Winn Co.)	110,074	-	328	110,402	-	122	108,225	2,055	-	-	56	83,000	15,000
Catahoula Lake[2]	-	-	21,000	21,000	-	-	21,000	-	-	-	-	-	-
Barksdale Air Force Base	17,469	200	807	18,476	-	18,476	-	-	-	-	158	72,415	500
Bayou Bodcau Reservoir	32,306	-	1,340	33,646	-	33,646	-	-	-	-	1,747	248,668	23,000
Natchitoches Nat. Fish Hatchery	40	3	55	98	-	-	98	-	-	-	-	3,000	-

CHART 8
Red River Basin
Acreages Classification and Attendance for Recreation Areas

Area (Louisiana, cont'd.)	Land	Wetland	Water	Total	Class I[1]	Class II[1]	Class III[1]	Class IV[1]	Class V[1]	Class VI[1]	Acres Developed Recreation Area	Reported Day Visits	Attendan Overnigh
England Air Force Base	116	-	-	116	-	116	-	-	-	-	16	[illegible]	-
Thistlethwaite Game Mgt. Area	11,000	-	-	11,000	-	-	11,000	-	-	-	-	10,000	-
Fort Jessup State Hist. Monument	22	-	-	22	-	-	-	-	-	22	6	11,346	-
Lincoln Parish Pk. and Boat Launching Ramp	5	-	1	6	-	6	-	-	-	-	6	-	-
Jackson-Bienville Game	10,820	-	-	10,820	-	-	10,820	-	-	-	-	-	-
Chatham Lake (Game res. open for hunting)	-	10	40	50	-	50	-	-	-	-	-	200	-
Chicot State Park[2]	4,480	-	1,625	6,105	-	2,780	3,325	-	-	-	121	49,421	18,943
Cheatham Park	17	-	-	17	17	-	-	-	-	-	17	-	-
Bringhurst Park	77	-	-	77	77	-	-	-	-	-	76	100,000	-
Saline Game Mgt. Area	39,019	10,000	1,000	50,019	-	-	50,019	-	-	-	-	15,000	-
Catahoula Ntl. Wildlife Refuge	50	10	30	90	-	-	90	-	-	-	11	5,356	-
Marksville Prehistoric Indian St. Pk. Monu.	44	-	-	44	-	9	30	-	-	5	37	250,000	-
Cross Lake	85	-	8,575	8,660	-	85	8,575	-	-	-	85	-	-
Black Bayou Lake	-	-	3,960	3,960	-	-	3,960	-	-	-	-	-	-
Black and Saline Lakes	70	-	22,080	22,150	-	70	22,080	-	-	-	-	-	-
Iatt Lake	-	-	7,100	7,100	-	-	7,100	-	-	-	-	-	-
Smithport Lake	-	-	2,950	2,950	-	-	2,950	-	-	-	-	-	-
Cane River Lake	-	-	1,350	1,350	-	-	1,350	-	-	-	-	-	-
Cantachie Lake	-	-	1,580	1,580	-	-	1,580	-	-	-	-	-	-
Louisiana Totals	725,821	18,203	121,200	865,224	470	67,371	794,696	2,645	5	37	3,688	2,116,800	125,600

1. Class I High Density Recreation - Class III Natural Environment - Class V Primitive Area
Class II General Outdoor Recreation - Class IV Outstanding Natural Features - Class VI Historical and Cultural Sites

2. Additional supply inside the study area but outside the drainage basin.

CHART 8
Red River Basin
Acreages Classification and Attendance for Recreation Areas

Area (Arkansas)	Land	Wetland	Water	Total	Class I[1]	Class II[1]	Class III[1]	Class IV[1]	Class V[1]	Class VI[1]	Acres Developed Recreation Area	Reported Day Visits	Attendance Overnight
Calhoun Heights	15	-	-	15	-	15	-	-	-	-	12	21,000	-
Bois de Arc Public Hunt Area	2,000	4,750	750	7,500	-	-	4,000	-	3,500	-	202	N/A	-
Bois de Arc Reservoir	-	-	705	705	-	705	-	-	-	-	2	6,000	300
Fair Park	40	-	-	40	-	40	-	-	-	-	22	22,500	-
Hope City Park	20	-	-	20	-	20	-	-	-	-	12	30,000	-
Lake June Park	6	-	60	66	-	66	-	-	-	-	1	3,000	-
Sulphur River Wildlife	10,000	-	-	10,000	-	-	-	-	10,000	-	2	175,000	5,000
White Oak Lake[2]	5,200	-	2,676	2,876	-	2,676	5,200	-	-	-	3	55,000	2,000
Nevada County Recreation Area	14	-	-	14	-	14	-	-	-	-	8	30,000	-
Queen Wilhelmina State Park	640	-	-	640	-	540	100	-	-	-	216	6,400	800
Lake Wilhelmina	40	-	300	340	-	340	-	-	-	-	3	35,000	15,000
Janssen Park	-	-	10	10	-	9	-	-	-	-	3	10,500	-
Ouachita National Forest (Polk County)	190,875	-	1,751	192,626	-	951	191,265	410	-	-	30	134,000	29,500
Dierks Park	35	-	-	35	-	35	-	-	-	-	14	30,000	-
Ouachita National Forest (Howard County)	1,200	-	46	1,246	-	-	1,246	-	-	-	-	45,000	-
Texarkana Air Force Station	1	-	-	1	-	1	-	-	-	-	-	-	-
Arkansas Totals	210,086	4,750	6,298	221,133	-	5,412	201,811	410	13,500	-	530	603,400	52,600

1. Class I High Density Recreation - Class III Natural Environment - Class V Primitive Area
Class II General Outdoor Recreation - Class IV Outstanding Natural Features - Class VI Historical and Cultural Sites

2. Additional supply inside the study area but outside the drainage basin.

CHART 8
Red River Basin
Acreages Classification and Attendance for Recreation Areas

Area (Oklahoma)	Land	Wetland	Water	Total	Class I[1]	Class II[1]	Class III[1]	Class IV[1]	Class V[1]	Class VI[1]	Acres Developed Recreation Area	Reported Day Visits	Attendance Overnight
Stringtown Mgt. Area	2,260	-	-	2,260	-	-	2,260	-	-	-	55	4,500	5,000
Boggy Depot Rec. Area	39	-	-	39	-	-	-	-	-	39	39	5,172	347
Lake Atoka Reservation	9,900	-	5,900	15,800	5	795	15,000	-	-	-	1,543	16,200	350
Durant City Park	14	-	-	14	14	-	-	-	-	-	10	30,000	-
Durant Fish Hatchery	400	-	350	750	-	750	-	-	-	-	-	500	-
Talihina Agency	119,950	-	86	120,036	-	45	119,986	-	-	5	15	450,000	25,000
Choctaw Chief Hs. Hist. Site	1	-	-	1	-	-	-	-	-	1	-	-	-
Raymond Gary State Rec. Area	60	-	-	60	-	60	-	-	-	-	14	15,539	3,119
Raymond Gary Lake	-	-	390	390	-	390	-	-	-	-	21	10,000	2,000
Schooler Lake	130	-	35	165	-	165	-	-	-	-	-	1,200	200
Ouachita Nt. For.	223,880	-	916	224,796	-	1,542	223,254	-	-	-	42	148,400	35,800
Choctaw Game Mgt. Area	184,000	-	2,000	186,000	1,000	1,000	170,000	-	13,900	100	1,000	165,800	15,000
McCurtain Co. Game Preserve	15,250	-	10	15,260	-	-	-	-	15,260	-	-	7,500	1,500
Beavers Bend State Park	1,260	10	30	1,300	-	1,300	-	-	-	-	-	697,016	78,584
Pushmataha Refuge	18,600	-	40	18,640	-	-	18,640	-	-	-	-	54,000	-
Nanih Waiya	109	-	131	240	-	240	-	-	-	-	-	5,200	20
Ozzie Cobb	225	117	-	342	-	342	-	-	-	-	-	1,500	20
Clayton Lake State Rec. Area	500	10	85	595	-	595	-	-	-	-	-	31,051	3,226
Atoka Game Refuge	6,400	-	-	6,400	-	-	6,400	-	-	-	-	3,000	-
Pittsburg Co. Wildlife Refuge	1,385	-	-	1,385	-	-	1,385	-	-	-	-	100	50
Additional Supply[2]	307,698	1,500	81,572	390,770	-	24,220	365,165	-	1,280	105	620	1,276,000	126,500
Oklahoma Totals	892,061	1,637	91,545	985,243	1,019	31,444	922,090	-	30,440	250	3,359	2,926,000	296,500

1. Class I High Density Recreation - Class III Natural Environment - Class V Primitive Area
Class II General Outdoor Recreation - Class IV Outstanding Natural Features - Class VI Historical and Cultural Sites

2. Additional supply inside the study area but outside the drainage basin.

CHART 8
Red River Basin
Acreages Classification and Attendance for Recreation Areas

Area (Texas)	Land	Wetland	Water	Total	Class I[1]	Class II[1]	Class III[1]	Class IV[1]	Class V[1]	Class VI[1]	Acres Developed Recreation Area	Reported Day Visits	Attendance Overnight
Texarkana Reservoir	48,578	-	29,200	77,778	-	77,778	-	-	-	-	564	2,167,686	216,768
Red River Army Depot	19,384	-	501	19,885	-	19,885	-	-	-	-	120	3,298	300
Atlanta State Rec. Park	1,475	-	-	1,475	-	5	1,470	-	-	-	5	10,000	2,103
Panhandle N.G.	473	-	47	520	-	-	-	-	-	-	33	2,000	7,000
Panhandle N.G.	1,030	-	450	1,480	-	1,480	-	-	-	-	9	6,800	1,200
Bonham State Rec. Park	235	-	65	300	-	-	292	-	-	-	8	54,193	1,172
Panhandle N.G.	14,309	-	-	14,309	-	-	14,309	-	-	-	-	8,000	1,600
Panhandle N.B.	670	-	750	1,420	-	1,420	-	-	-	-	5	7,300	1,500
Eisenhower Birthplace Hist. Site	3	-	-	3	-	-	-	-	-	3	3	24,447	-
Loy Park	310	-	40	350	-	200	150	-	-	-	12	4,000	150
Longhorn Army Ammo Plant	8,524	-	-	8,524	-	8,524	-	-	-	-	-	914	53
Caddo Lake State Park	446	2	30	478	-	11	452	15	-	-	11	9,544	7,864
Lake O'the Pines	10,406	-	18,700	29,106	-	29,106	-	-	-	-	574	3,298,555	450,000
Daingerfield State Rec. Area	471	-	80	551	-	15	536	-	-	-	14	32,155	2,610
Lake Gladewater	15	-	900	915	-	-	915	-	-	-	35	51,810	-
Small Rec. Sites (3) Hunt Co.	33	-	-	33	33	-	-	-	-	-	38	N/A	-
Small Rec. Sites (1) Hopkins Co.	4	-	-	4	4	-	-	-	-	-	4	N/A	-
Small Rec. Sites (6) Grayson Co.	25	-	-	25	25	-	-	-	-	-	25	88,000	-
Small Rec. Sites (3) Harrison Co.	250	-	-	250	250	-	-	-	-	-	250	30,000	-
Caddo Lake	-	-	19,500	19,500	-	19,500	-	-	-	-	-	-	-
Additional Supply[2]	17,936	1,000	67,475	86,411	100	83,511	-	-	-	-	-	-	-
Texas Totals	124,577	1,002	137,738	263,316	412	241,435	18,124	15	-	3	2,145	5,946,402	723,932
Grand Totals	1,366,902	24,455	344,013	1,736,370	882	338,438	1,377,001	3,070	13,505	290	9,722	11,592,600	1,198,600

1. Class I High Density Recreation - Class III Natural Environment - Class V Primitive Area
Class II General Outdoor Recreation - Class IV Outstanding Natural Features - Class VI Historical and Cultural Sites

2. Additional supply inside the study area but outside the drainage basin.

CHART 9

Existing Recreation Facilities at Known Public Recreation Areas

Subarea	Natural Lakes & Impounded Water		Beach		Boat Access & Parking		Swimming Pools		Picnic Areas		Picnic Tables	Camping		Camping Spaces		Group Camping			General Parking	
	Acres	Sites	Acres	Sites	Acres	Sites	Sq. Ft.	Sites	Acres	Sites		Acres	Sites	Tents	Trailers	Acres	Sites	People	Acres	Spaces
Oklahoma	81,572	23	32	10	88	30	3,600	1	1,584	80	1,052	320	50	813	166	684	6	690	81	2,250
Texas	137,738	4	16	17	33	29	45,975	10	812	91	1,512	144	51	486	396	393	8	400	137	4,340
Arkansas	6,298	8	2	2	1	1	25,250	5	333	23	143	59	4	44	-	-	-	-	87	1,944
Louisiana	118,405	31	24	13	31	31	93,425	12	286	71	600	100	31	215	77	1,849	39	1,122	72	5,420
Basin Total	344,013	76	74	42	153	100	167,250	28	3,015	265	3,306	623	136	1,558	639	2,921	53	2,212	377	14,565

Programmed Recreation Developments by 1970

Oklahoma	-	-	13	1	51	14	-	-	69	4	518	233	13	648	66	120	2	240	14	935
Texas	-	-	19	9	16	27	-	-	150	14	800	134	9	276	228	6	2	70	15	424
Arkansas	-	-	4	4	3	1	-	-	45	7	191	156	20	468	-	-	-	-	5	555
Louisiana	-	-	5	7	17	16	-	-	99	23	177	112	14	155	47	7	1	50	18	2,370
Basin Total	-	-	41	21	87	58	-	-	363	48	1,686	635	56	1,547	341	133	5	360	52	4,284
Basin Total 1970	344,013	76	115	63	240	158	167,250	28	3,378	313	4,992	1,258	192	3,005	980	3,054	58	2,572	429	18,849

CHART 10

Total Basin
Existing and Projected Average Summer Sunday Demand
and Needs (Needs expressed in Facilities)

	Boating	Swimming	Camping	Picnicking
1965 Average Summer Sunday Demand	76,000	91,000	57,000	94,000
1962 Supply, Public and Private	172,000	64,000	11,900	36,000
1965 Needs	+96,000	27,000	45,100	58,000
1965 Need in Facilities	-	45 Acres	9,000 Units	5,800 Tables
1980 Average Summer Sunday Demand	141,000	168,000	106,000	175,000
1970 Supply, Public and Private	172,000	64,000	18,000	54,000
1980 Needs	+31,000	104,000	88,000	121,000
1980 Need in Facilities	-	173 Acres	17,600 Units	12,100 Tables
2020 Average Summer Sunday Demand	626,000	749,000	470,000	776,000
1970 Supply, Public and Private	172,000	64,000	18,000	54,000
2020 Needs	454,000	685,000	452,000	722,000
2020 Need in Facilities	908,000 Acres	1,140 Acres	90,000 Units	72,000 Tables

CHART 10

Louisiana Subarea
Existing and Projected Average Summer Sunday Demand
and Needs (Needs expressed in Facilities)

	Boating	Swimming	Camping	Picnicking
1965 Average Summer Sunday Demand	33,600	40,200	25,300	41,700
1962 Supply, Public and Private[1]	68,000	25,900	1,680	6,900
1965 Needs	+34,400	14,300	24,620	34,800
1965 Need in Facilities	-	24 Acres	4,900 Units	3,480 Tables
1980 Average Summer Sunday Demand	62,600	74,700	47,000	77,500
1970 Supply, Public and Private[1]	68,000	25,900	2,800	8,900
1980 Needs	+5,400	48,800	44,200	68,600
1980 Need in Facilities	-	80 Acres	8,800 Units	6,860 Tables
2020 Average Summer Sunday Demand	296,000	353,000	222,000	366,000
1970 Supply, Public and Private[1]	68,000	25,900	2,800	8,900
2020 Needs	228,000	327,100	194,000	357,000
2020 Need in Facilities	456,000 Acres	540 Acres	38,800 Units	35,700 Tables

1. Private supply estimated to be equal to 5 percent of public supply.

CHART 10

Arkansas Subarea
Existing and Projected Average Summer Sunday Demand
and Needs (Needs expressed in Facilities)

	Boating	Swimming	Camping	Picnicking
1965 Average Summer Sunday Demand	5,200	6,200	3,800	6,400
1962 Supply, Public and Private[1]	3,250	3,300	230	1,470
1965 Needs	1,950	2,900	3,570	4,930
1965 Need in Facilities	3,900 Acres	5 Acres	710 Units	490 Tables
1980 Average Summer Sunday Demand	9,100	10,900	6,800	11,300
1970 Supply, Public and Private[1]	3,250	3,300	2,650	3,400
1980 Needs	5,850	7,600	4,150	7,900
1980 Need in Facilities	11,700 Acres	13 Acres	830 Units	790 Tables
2020 Average Summer Sunday Demand	42,000	50,000	31,400	51,700
1970 Supply, Public and Private[1]	3,250	3,300	2,650	3,400
2020 Needs	38,750	46,700	28,750	48,300
2020 Need in Facilities	77,500 Acres	78 Acres	5,750 Units	4,830 Tables

1. Private supply estimated to be equal to 3 percent of public supply.

CHART 10

Oklahoma Subarea
Existing and Projected Average Summer Sunday Demand
and Needs (Needs expressed in Facilities)

	Boating	Swimming	Camping	Picnicking
1965 Average Summer Sunday Demand	9,900	11,900	7,500	12,300
1962 Supply, Public and Private[1]	42,800	20,400	5,140	11,000
1965 Needs	+32,900	+8,500	2,360	1,300
1965 Need in Facilities	-	-	470 Units	130 Tables
1980 Average Summer Sunday Demand	16,700	20,000	12,600	21,000
1970 Supply, Public and Private[1]	42,800	20,400	8,900	16,400
1980 Needs	+26,100	+400	3,700	4,600
1980 Need in Facilities	-	-	740 Units	460 Tables
2020 Average Summer Sunday Demand	68,000	82,000	51,000	85,000
1970 Supply, Public and Private[1]	42,800	20,400	8,900	16,400
2020 Needs	25,200	61,600	42,100	68,600
2020 Need in Facilities	50,400 Acres	100 Acres	8,400 Units	6,800 Tables

1. Private supply estimated to be equal to 5 percent of public supply.

CHART 10

Texas Subarea
Existing and Projected Average Summer Sunday Demand
and Needs (Needs expressed in Facilities)

	Boating	Swimming	Camping	Picnicking
1965 Average Summer Sunday Demand	27,600	33,000	20,800	34,000
1962 Supply, Public and Private[1]	75,750	14,500	4,850	16,600
1965 Needs	+48,050	18,500	15,950	17,400
1965 Need in Facilities	-	31 Acres	3,190 Units	1,740 Tables
1980 Average Summer Sunday Demand	52,500	62,700	39,500	65,000
1970 Supply, Public and Private[1]	75,750	14,500	7,600	25,400
1980 Needs	+23,250	48,200	21,900	39,600
1980 Need in Facilities	-	80 Acres	4,380 Units	3,960 Tables
2020 Average Summer Sunday Demand	220,000	264,000	166,000	273,000
1970 Supply, Public and Private[1]	75,750	14,500	7,600	25,400
2020 Needs	144,250	264,500	158,400	247,600
2020 Need in Facilities	288,500 Acres	460 Acres	31,680 Units	24,760 Tables

1 Private supply estimated to be equal to 10 percent of public supply.

CHART 11

Annual Outdoor Recreation Capacity and Monetary
Benefits of Proposed Corps of Engineers Projects
Early-Action Plan

Reservoir	Surface Acres	Minimum Development 2020 Recreation Day Annual	Value of Recreation Day	Benefits to Recreation	Initial Development 1980 Recreation Days Annual	Value of Recreation Day	Benefits to Recreation	Optimum Development 2020 Recreation Days Annual	Value of Recreation Day	Benefits to Recreation
Kisatchie	9,180	170,000	$0.50	$ 85,000	880,000	$1.00	$ 880,000	1,760,000	$1.50	$2,640,000
Dorcheat	17,300	325,000	0.50	162,500	1,600,000	1.00	1,600,000	3,300,000	1.50	4,950,000
Parker	6,170	86,000	0.50	43,000	440,000	0.75	330,000	880,000	1.00	880,000
Bonham	5,280	100,000	0.50	50,000	500,000	0.75	375,000	1,000,000	1.00	1,000,000
Albany	4,960	48,000	0.50	24,000	240,000	0.75	180,000	480,000	1.00	480,000
Durant	8,980	86,000	0.50	43,000	430,000	0.75	322,500	860,000	1.00	860,000
Liberty Hill	7,070	100,000	0.50	50,000	500,000	0.75	375,000	1,000,000	1.00	1,000,000
Sherwood	30,740	76,000	0.50	38,000	750,000	0.75	562,500	1,500,000	1.00	1,500,000

CHART 12

Louisiana

Estimated Capacity to Offer Outdoor
Recreational Opportunity in Activity Occasions - Average Summer Sunday

Site	Agency	Surface Acres	Boating Average Summer Sunday Activity Occasions 1980	2020	Swimming Average Summer Sunday Activity Occasions 1980	2020	Camping Average Summer Sunday Activity Occasions 1980	2020	Picnicking Average Summer Sunday Activity Occasions 1980	2020	Other Average Summer Sunday Activity Occasions 1980	2020	Total[1] Average Summer Sunday Activity Occasions 1980	2020
Proposed Programs														
Kisatchie	CE	9,180	4,590		11,000	5,500	6,880	3,440	11,600	5,800	19,800	9,900	53,870	78,510
CNI-3-57A	SCS	60	-	60	-	150	-	90	-	150	-	260	-	710
CNI-3M2-4	SCS	98	50	25	120	60	75	35	125	60	210	100	580	860
CNI-3-68 (Cotile)	SCS	1,030	500	250	1,240	600	770	375	1,300	650	2,200	1,100	6,010	8,985
CNI-3M2-3	SCS	1,220	600	300	1,470	750	900	450	1,550	750	2,600	1,300	7,120	10,670
CNI-3N-2	SCS	1,950	975	490	2,350	1,170	1,460	700	2,470	1,200	4,200	2,100	11,455	17,115
CNI-3-70	SCS	480	240	120	580	300	360	180	600	300	1,000	500	2,780	4,180
Dogwood Rec. Area	USFS	-	-	-	-	-	55	55	110	110	200	200	365	730
Livington Rec. Area	USFS	-	-	-	-	-	55	55	110	110	200	200	365	730
Magnolia Rec. Area	USFS	-	-	-	-	-	60	60	120	120	240	240	420	840
Stuart Lake	USFS	3	-	-	600	-	55	55	110	110	200	200	965	1,330
Bayou Boeuf Rec. Area	USFS	1,290	650	325	1,550	750	960	480	1,600	800	2,780	1,350	7,540	11,245
Indian Creek	SCS	1,125	560	280	1,350	650	840	400	1,400	700	2,400	1,200	6,550	9,780
Total		16,436	8,165	1,850	20,260	9,930	12,470	6,375	21,095	10,860	36,030	18,650	98,020	145,685
Enlargement of Existing Areas[2]	-	-	5,200	-	12,000	-	7,500	-	12,500	-	43,000	-	80,200	80,200
Bank Stabilization and Navigation Projects	CE	-	-	4,000	-	-	-	2,300	-	6,600	-	7,400	-	20,300

1. The 2020 total is accumulative including 1980.

2. This total is above the present developments.

CHART 12
Arkansas

Estimated Capacity to Offer Outdoor
Recreational Opportunity in Activity Occasions - Average Summer Sunday

Site	Agency	Surface Acres	Boating Average Summer Sunday Activity Occasions 1980	Boating 2020	Swimming Average Summer Sunday Activity Occasions 1980	Swimming 2020	Camping Average Summer Sunday Activity Occasions 1980	Camping 2020	Picnicking Average Summer Sunday Activity Occasions 1980	Picnicking 2020	Other Average Summer Sunday Activity Occasions 1980	Other 2020	Total[1] Average Summer Sunday Activity Occasions 1980	Total[1] 2020
Proposed Programs														
Dorcheat Res.[2]	CE	17,300	4,300	4,300	10,400	10,400	6,500	3,200	10,900	5,500	18,600	18,600	50,700	92,700
Millwood Res.[2]	CE	24,500	6,100	6,100	14,700	-	9,200	-	15,500	-	26,400	-	71,900	78,000
DeQueen[2]	CE	1,680	420	420	1,000	1,000	630	630	1,060	530	1,800	1,800	4,910	9,290
Dierks[2]	CE	1,360	340	340	800	800	500	500	860	430	1,390	1,390	3,890	7,350
Gillham[2]	CE	1,370	340	340	800	800	500	500	860	430	1,400	1,400	3,900	7,370
CN1-3J-4	SCS	87	45	20	100	50	65	30	110	50	190	90	510	750
CN1-3-52	SCS	230	115	60	280	140	170	80	290	150	490	250	1,345	2,025
CN1-3-57	SCS	110	55	20	130	70	80	40	140	70	240	120	645	965
CN1-3M1-7 (Site 7)	SCS	170	85	40	200	100	130	100	220	100	360	180	995	1,515
Rock Creek	USFS	90	45	20	100	50	70	40	110	50	190	90	515	765
Smoke Rock Creek	USFS	50	25	15	60	30	40	20	60	30	100	50	285	430
Talimena Scenic Drive	USFS	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		46,947	11,870	11,675	28,570	13,440	17,885	5,140	30,110	7,340	51,160	23,970	139,595	201,160
Enlargement of Existing Areas[3]	-	-	75	50	-	-	600	600	1,200	1,200	1,800	1,800	3,675	7,325
Bank Stabilization and Navigation Projects	CE	-	-	1,800	-	-	-	800	-	2,400	-	2,800	-	7,800

1. The 2020 total is accumulative including 1980.

2. Constructed or under construction.

3. This total is above the present development.

CHART 12
Oklahoma

Estimated Capacity to Offer Outdoor
Recreational Opportunity in Activity Occasions - Average Summer Sunday

Site	Agency	Surface Acres	Boating Average Summer Sunday Activity Occasions 1980	Boating 2020	Swimming Average Summer Sunday Activity Occasions 1980	Swimming 2020	Camping Average Summer Sunday Activity Occasions 1980	Camping 2020	Picnicking Average Summer Sunday Activity Occasions 1980	Picnicking 2020	Other Average Summer Sunday Activity Occasions 1980	Other 2020	Total[1] Average Summer Sunday Activity Occasions 1980	Total[1] 2020
Proposed Programs														
Broken Bow Res.[2]	CE	14,200	7,100	3,500	17,100	8,500	10,600	5,300	18,000	-	30,600	15,300	83,400	116,000
Eufaula Res.[3]	CE	1,100	280	280	660	330	400	200	700	-	1,200	600	600	4,650
Pine Creek Res.[2]	CE	3,800	950	950	3,000	1,500	1,400	700	2,400	-	4,100	2,000	11,850	17,000
Hugo Res[2]	CE	13,250	1,650	1,650	4,000	4,000	2,500	2,500	4,200	-	7,150	7,150	19,500	34,800
Boswell Res.[3]	CE	5,540	700	700	1,700	-	1,000	1,000	1,750	-	3,000	3,000	8,150	12,850
Clayton Res.[3]	CE	8,900	2,200	1,100	5,300	2,600	3,300	1,650	5,600	-	9,600	4,800	26,000	36,150
Tuskahoma Res.[3]	CE	11,600	2,900	1,450	7,000	-	4,350	2,100	7,300	-	12,500	6,200	34,050	43,800
Albany Res.	CE	4,960	620	620	1,500	750	930	930	1,600	800	2,700	2,700	7,350	13,150
Durant Res.	CE	8,980	1,120	1,120	2,700	1,350	1,600	800	2,840	1,400	4,840	2,400	13,180	20,250
Parker Res.	CE	6,170	1,540	770	1,850	900	1,150	550	1,950	900	3,300	1,600	9,790	14,510
Sherwood Res.	CE	30,740	3,850	3,850	9,250	9,250	5,750	5,750	4,600	4,600	16,500	16,600	39,950	80,000
CNI-3-35	SCS	100	50	25	120	60	75	40	130	60	220	100	595	880
CNI-3-41	SCS	100	25	25	60	60	40	40	60	60	110	100	295	580
CNI-3-23	SCS	235	120	60	280	140	180	90	300	150	500	250	1,380	2,070
CNI-31-4	SCS	345	170	80	400	200	260	130	440	220	740	370	2,010	3,010
Billy Creek	USFS	1 mile of stream	-	-	-	-	100	100	150	150	400	400	650	1,300
Cedar Lake	USFS	84	40	20	100	50	65	30	100	50	180	90	485	725
America Lake	USFS	125	60	30	150	80	90	50	160	80	270	130	730	1,100
Caney Lake	USFS	125	60	30	150	80	90	50	160	80	270	130	730	1,100
Moon Lake	USFS	200	100	50	240	120	150	80	250	130	430	200	1,170	1,750
Talimena Scenic Road		-	-	-	-	-	-	-	-	-	-	-	-	-
Total		110,554	23,535	16,310	55,560	29,870	34,110	20,090	52,690	8,680	98,610	64,120	264,505	405,575
Enlargement of Existing Areas[4]	-	-	480	240	1,000	900	1,540	950	1,400	440	3,850	2,500	8,270	13,300
Bank Stabilization and Navigation Projects[5]	CE	-	-	1,200	-	-	-	500	-	1,000	-	2,000	-	4,700

1. The 2020 total is accumulative including 1980.

2. Constructed or under construction.

3. Authorized.

4. This total is above the present developments.

5. This project is considered only as potential because State boundary conflicts must be resolved.

XII-70

CHART 12
Texas

Estimated Capacity to Offer Outdoor
Recreational Opportunity in Activity Occasions - Average Summer Sunday

Site	Agency[2]	Surface Acres	Boating Average Summer Sunday Activity Occasions 1980	Boating 2020	Swimming Average Summer Sunday Activity Occasions 1980	Swimming 2020	Camping Average Summer Sunday Activity Occasions 1980	Camping 2020	Picnicking Average Summer Sunday Activity Occasions 1980	Picnicking 2020	Other Average Summer Sunday Activity Occasions 1980	Other 2020	Total[1] Average Summer Sunday Activity Occasions 1980	Total[1] 2020
Proposed Programs														
Pecan Bayou Res.	TWDB	16,160	-	8,000	-	19,500	-	12,000	-	20,400	-	34,800	-	94,700
Titus County	TWDB	12,200	-	6,100	-	14,700	-	9,150	-	15,400	-	26,300	-	71,650
Sulphur Bluff Res.	TWDB	40,700	-	10,200	-	24,500	-	15,300	-	25,800	-	44,000	-	119,800
Marshall	TWDB	32,000	-	8,000	-	19,300	-	12,000	-	20,200	-	34,500	-	94,000
Bonnan Res.	CE	5,280	1,320	640	3,180	1,590	1,980	990	3,340	1,670	5,700	2,800	15,520	33,210
Liberty Hill Res.	CE	7,070	1,770	880	4,260	2,100	2,650	1,300	4,480	2,200	7,600	3,800	20,760	31,040
Naples Res.	CE	108,200	-	27,000	-	65,000	-	40,500	-	68,500	-	116,000	-	317,000
Cooper Res.[3]	CE	19,270	4,800	4,800	11,600	11,600	7,200	7,200	12,200	12,200	20,800	20,800	56,600	113,200
Pat Mayse[3]	CE	5,993	3,000	-	7,200	-	4,300	-	7,600	-	12,900	-	35,000	35,000
Big Pine[3]	CE	4,640	-	2,300	-	5,600	-	3,500	-	5,900	-	10,000	-	27,300
Franklin County	TWDB	3,500	-	1,750	-	4,200	-	2,600	-	4,400	-	7,600	-	20,550
Timber Creek	IWDB	1,020	500	250	1,200	600	760	380	1,300	650	2,200	1,100	5,960	8,940
CNI-3-19 (Site 35)	SCS	250	125	60	300	150	180	90	320	160	540	270	1,465	2,195
(Site 38)	SCS	52	25	15	60	30	40	20	65	30	110	50	300	445
CNI-3-25a	SCS	340	170	80	400	200	250	120	430	210	730	360	1,980	2,950
CNI-3-29	SCS	50	25	15	60	30	35	20	60	30	100	50	280	425
CNI-3K-14	SCS	300	150	70	360	180	220	110	380	190	650	300	1,760	2,610
CNI-3K-11	SCS	187	-	90	-	230	-	140	-	240	-	400	-	1,100
Totals		257,212	11,885	70,250	28,620	169,510	17,615	105,420	30,175	178,180	51,330	303,130	139,625	966,115
Enlargement of Existing Areas[4]	-	-	8,800	-	39,000	-	26,500	-	26,900	-	64,000	-	165,200	165,200
Enlargement of Caddo, Texarkana and Lake O'the Pines Reservoirs[5]	-	-	-	35,500	-	86,300	-	52,000	-	88,900	-	151,800	-	414,500
Bank Stabilization and Navigation Projects[6]	CE	-	-	1,000	-	-	-	400	-	1,200	-	1,400	-	4,000

1. The 2020 total is accumulative including 1980.

2. The agency that will administer some of the reservoirs marked TWDB or C/E has not been determined at this time.

3. Authorized.

4. This total is above the present capacity.

5. Total capacity based on new surface acreage. Capacity includes existing facilities which will be moved above new water level.

6. This project is considered only as potential because State boundary conflicts must be resolved.

XII-71

CHART 13

Louisiana
Facilities and Acreages Required to Offer the Estimated Capacity of Outdoor Recreational Opportunity on an Average Summer Sunday

Site	Surface Acres	Boating				Swimming		Camping				Picnicking			
		Ramps		Acres		Acres of Beach		Units		Acres		Tables		Acres	
		1980	2020	1980	2020	1980	2020	1980	2020	1980	2020	1980	2020	1980	2020
Proposed Programs															
Kisatchie	9,180	38	-	76	-	18	8	1,375	680	1,375	680	1,160	580	580	290
CNI-3-57a	60	-	1	-	2	-	1	-	18	-	18	-	15	-	8
CNI-3MZ-4	98	1	-	2	-	1	-	15	7	15	7	13	6	7	3
CNI-3-68 (Cotile)[1]	1,030	4	2	8	4	2	1	154	75	154	75	130	65	65	33
CNI-3MZ-3[1]	1,220	5	3	10	6	2	1	180	90	180	90	155	75	78	37
CNI-3N 2[1]	1,950	8	4	16	8	4	2	292	140	292	140	247	120	124	60
CNI-3-70	480	2	1	4	2	1	1	72	36	72	36	60	30	30	15
Dog Pond Rec. Area	-	-	-	-	-	-	-	11	11	11	11	11	11	6	5
Livingston Rec. Area	-	-	-	-	-	-	-	11	11	11	11	11	11	6	5
Magnolia Rec. Area	-	-	-	-	-	-	-	12	12	12	12	12	12	6	6
Stuart Lake	3	-	-	-	-	1	-	11	11	11	11	11	11	6	5
Bayou Boeuf Rec. Area[1]	1,290	6	2	12	4	3	1	192	96	192	96	160	80	80	40
Indian Creek[1]	1,125	5	2	10	4	3	1	168	80	168	80	140	70	70	35
Totals	16,436	69	15	128	30	35	16	2,493	1,267	2,493	1,267	2,110	1,086	980	482
Enlargement of Existing Areas	-	43	-	86	-	20	-	1,500	-	1,500	-	1,250	-	625	-
Bank Stabilization and Navigation Projects	-	-	33	-	66	-	-	-	460	-	460	-	660	-	300

1. Constructed or under construction.

CHART 13

Arkansas
Facilities and Acreages Required to Offer the Estimated Capacity of Outdoor Recreational Opportunity on an Average Summer Sunday

Site	Surface Acres	Boating				Swimming		Camping				Picnicking			
		Ramps		Acres		Ac. of Beach		Units		Acres		Tables		Acres	
		1980	2020	1980	2020	1980	2020	1980	2020	1980	2020	1980	2020	1980	2020
Proposed Programs															
Dorcheat Reservoir	17,300	36	36	72	72	17	17	1,300	640	1,300	640	1,090	550	545	275
Millwood Reservoir[1]	24,500	51	51	102	102	25	-	1,840	-	1,840	-	1,550	-	775	-
DeQueen[1]	1,680	4	4	8	8	4	4	126	126	126	126	106	53	53	27
Dierks[1]	1,360	3	3	6	6	2	1	100	100	100	100	86	43	43	22
Gillham[1]	1,370	3	3	6	6	2	1	100	100	100	100	86	43	43	22
CNI-3J-4	87	1	-	2	-	1	-	13	6	13	6	11	5	6	2
CNI-3-52	230	1	1	2	2	1	-	34	16	34	16	29	15	15	7
CNI-3-57	110	1	-	2	-	1	-	16	8	16	8	14	7	7	4
CNI-3M1-7 (Site 7)	170	1	-	2	-	1	-	26	10	26	10	22	10	11	5
Rock Creek	90	1	-	2	-	1	-	14	8	14	8	11	5	6	2
Smoke Rock Creek	50	1	-	2	-	1	-	8	4	8	4	6	3	3	2
Talimena Scenic Drive	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	46,947	103	98	206	196	56	23	3,577	1,018	3,577	1,018	3,011	734	1,507	368
Enlargement of Existing Areas	-	1	-	2	-	-	-	120	120	120	120	120	120	60	60
Bank Stabilization and Navigation Projects	-	-	15	-	30	-	-	-	160	-	160	-	240	-	120

1. Constructed or under construction.

CHART 13

Oklahoma

Facilities and Acreages Required to Offer the Estimated Capacity of Outdoor Recreational Opportunity on an Average Summer Sunday

Site	Surface Acres	Boating				Swimming		Camping				Picnicking			
		Ramps		Acres		Ac. of Beach		Units		Acres		Tables		Acres	
		1980	2020	1980	2020	1980	2020	1980	2020	1980	2020	1980	2020	1980	2020
Proposed Programs															
Broken Bow Res.[1]	14,200	59	29	118	58	29	14	2,120	1,060	2,120	1,060	1,800	-	900	-
Lukfata Res.[2]	1,100	2	3	4	6	1	1	80	40	80	40	70	-	35	-
Pine Creek Res.[1]	3,800	8	8	16	16	5	3	280	140	280	140	240	-	120	-
Hugo Res.[1]	13,250	14	14	28	28	7	7	500	500	500	500	420	-	210	-
Boswell Res.[2]	5,540	6	6	12	12	3	-	200	200	200	200	175	-	88	-
Clayton Res.[2]	8,900	18	9	36	18	9	4	660	330	660	330	560	-	280	-
Tuskahoma Res.[2]	11,600	24	12	48	24	12	-	870	420	870	420	730	-	365	-
Albany Res.	4,960	5	5	10	10	3	1	186	186	186	186	160	80	80	40
Durant Res.	8,980	9	9	18	18	5	3	320	160	300	160	280	140	140	70
Parker Res.	6,170	13	6	26	12	4	2	230	110	230	110	195	90	95	45
Sherwood Res.	30,740	32	32	64	64	15	16	1,375	1,375	1,375	1,375	460	460	230	230
CNI-3-35	100	1	-	2	-	1	-	15	8	15	8	13	6	7	3
CNI-3-41	100	1	-	2	-	1	-	8	8	8	8	6	6	3	3
CNI-3-23	235	1	1	2	2	1	-	36	18	36	18	30	15	15	8
CNI-3i-4	345	1	1	2	2	1	-	52	26	52	26	44	22	22	11
Billy Creek	1 mile of stream	-	-	-	-	-	-	20	20	20	20	15	15	8	7
Cedar Lake	84	1	-	2	-	1	-	13	6	13	6	10	5	5	3
America Lake	125	1	-	2	-	1	-	18	10	18	10	16	8	8	4
Caney Lake	125	1	-	2	-	1	-	18	10	18	10	16	8	8	4
Moon Lake	200	1	-	2	-	1	-	30	16	30	16	25	13	13	6
Talimena Scenic Road	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Totals	110,554	196	135	396	270	101	51	7,450	4,643	7,431	4,643	5,265	868	2,630	434
Enlargement of Existing Areas	-	4	2	8	4	2	1	308	190	308	190	140	44	70	22
Bank Stabilization and Navigation Projects	-	-	10	-	20	-	-	-	100	-	100	-	100	-	50

1. Constructed or under construction.

2. Authorized.

CHART 13

Texas

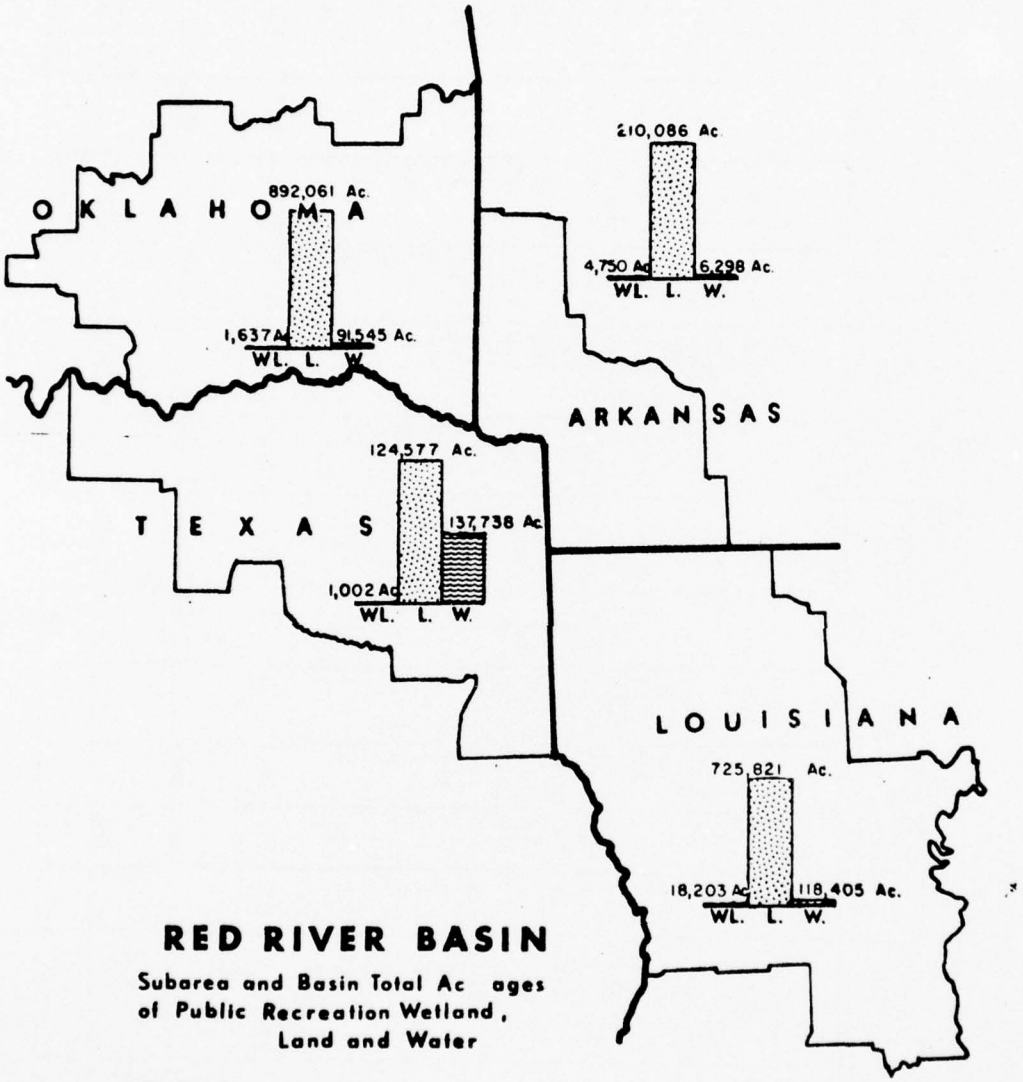
Facilities and Acreages Required to Offer the Estimated Capacity of Outdoor Recreational Opportunity on an Average Summer Sunday

Site	Surface Acres	Boating: Ramps 1980	Boating: Ramps 2020	Boating: Acres 1980	Boating: Acres 2020	Swimming: Ac. of Beach 1980	Swimming: Ac. of Beach 2020	Camping: Units 1980	Camping: Units 2020	Camping: Acres 1980	Camping: Acres 2020	Picnicking: Tables 1980	Picnicking: Tables 2020	Picnicking: Acres 1980	Picnicking: Acres 2020
Proposed Programs															
Pecan Bayou Res.	16,160	-	66	-	132	-	33	-	2,400	-	2,400	-	2,040	-	1,020
Titus County	12,200	-	50	-	100	-	25	-	1,830	-	1,830	-	1,540	-	770
Sulphur Bluff Res.	40,700	-	85	-	170	-	41	-	3,060	-	3,000	-	2,580	-	1,290
Marshall	32,000	-	67	-	134	-	32	-	2,400	-	2,400	-	2,020	-	1,010
Bonham Res.	5,280	11	7	22	14	6	3	400	200	400	200	340	170	170	85
Liberty Hill Res.	7,070	15	7	30	14	7	4	530	260	530	260	450	220	225	110
Naples Res.	108,200	-	225	-	450	-	108	-	8,100	-	8,100	-	6,850	-	3,425
Cooper Res.[1]	19,270	40	40	80	80	19	19	1,440	1,440	1,440	1,440	1,200	1,220	610	610
Pat Mayse[1]	5,993	25	-	50	-	12	-	860	-	860	-	760	-	380	-
Big Pine[1]	4,640	-	19	-	38	-	9	-	700	-	700	-	590	-	295
Franklin County	3,500	-	15	-	30	-	7	-	520	-	520	-	440	-	220
Timber Creek	1,020	4	2	8	4	2	1	152	76	152	76	130	65	65	33
CNI-3-19 (Site 35)	250	1	1	2	2	1	-	36	18	36	18	32	16	16	8
(Site 38)	52	1	-	2	-	1	-	8	4	8	4	7	3	4	1
CNI-3-25d	340	2	1	4	2	1	-	50	25	50	25	43	21	22	10
CNI-3-29	50	1	-	2	-	1	-	8	4	8	4	7	3	4	1
CNI-3K-14	300	1	1	2	2	1	-	45	23	45	23	38	19	19	10
CNI-3K-11	187	-	1	-	2	-	-	-	28	-	28	-	24	-	12
Total	257,212	101	587	202	1,174	51	282	3,529	21,088	3,529	21,088	3,027	17,781	1,515	8,910
Enlargement of Existing Areas	-	73	-	146	-	65	-	5,300	-	5,300	-	2,690	-	1,345	-
Enlargement of Caddo, Texarkana, and Lake O'the Pines Res.[2]	-	-	296	-	592	-	144	-	10,400	-	10,400	-	8,890	-	4,445
Bank Stabilization and Navigation Projects	-	-	8	-	16	-	-	-	80	-	80	-	120	-	60

1. Authorized.

2. These facilities include the existing prior to enlargement.

CHART 14



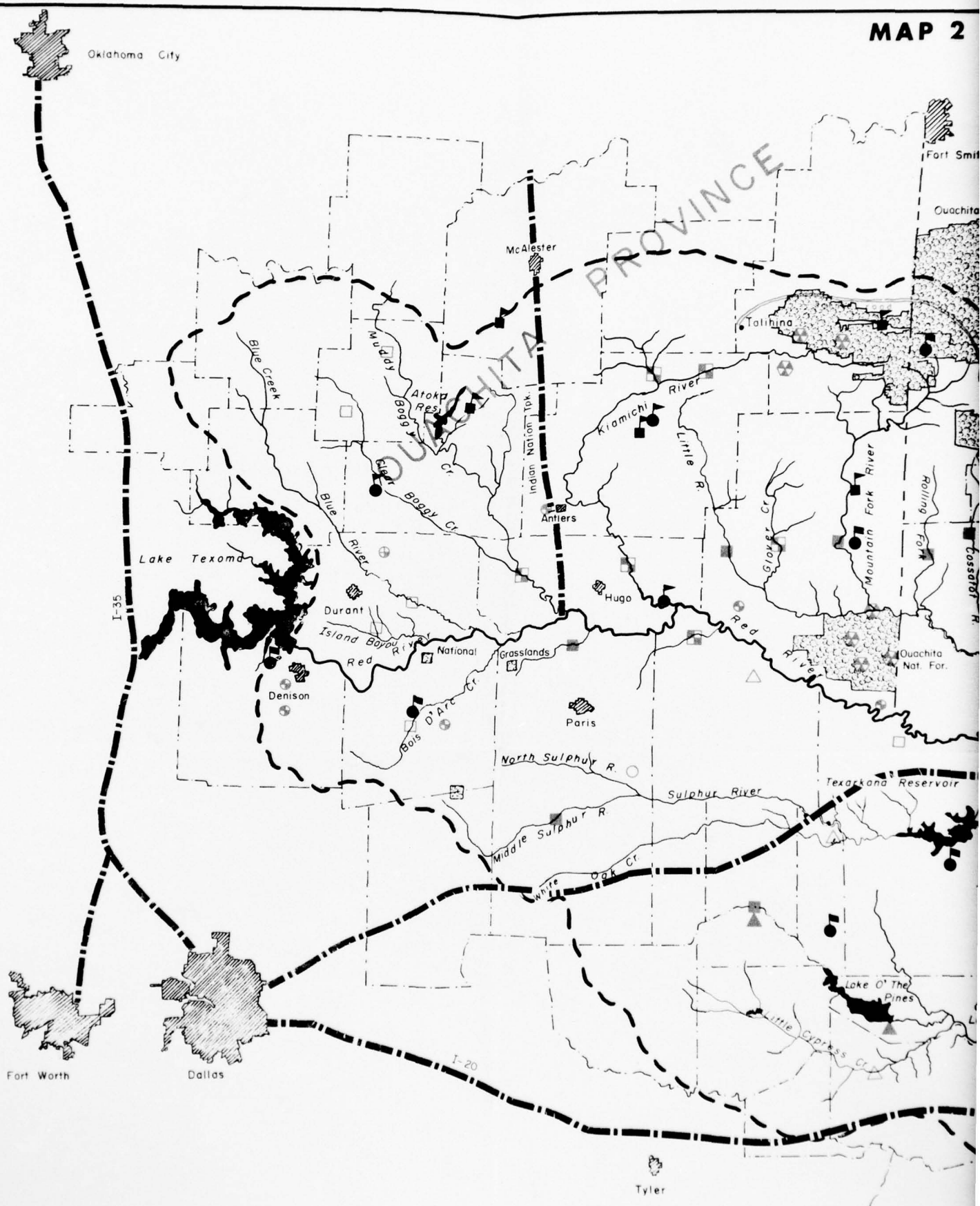
RED RIVER BASIN

Subarea and Basin Total Acreages of Public Recreation Wetland, Land and Water

Wetland	Land	Water
25,792 Ac.	1,952,940 Ac.	125,925 Ac.

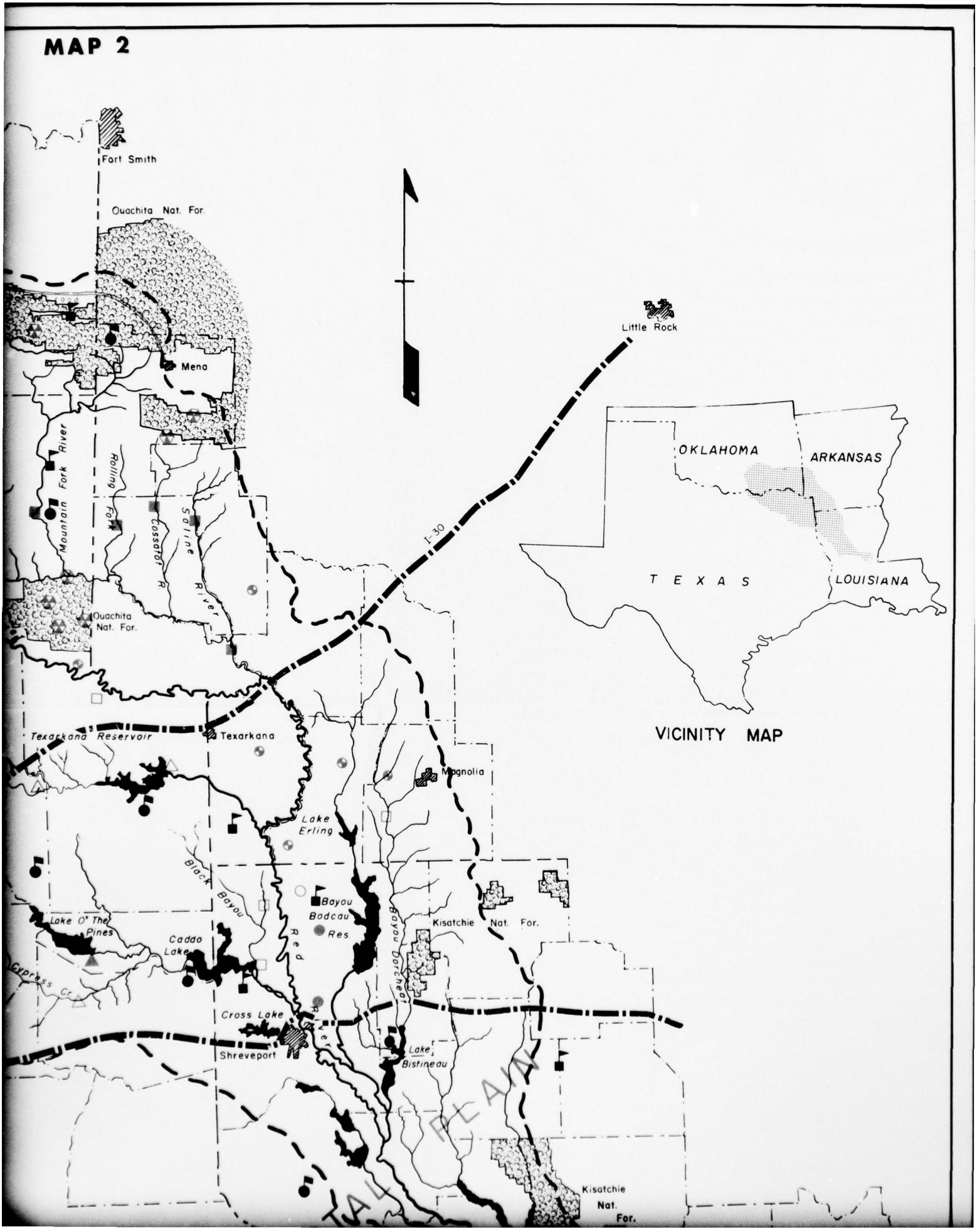
CHART 15

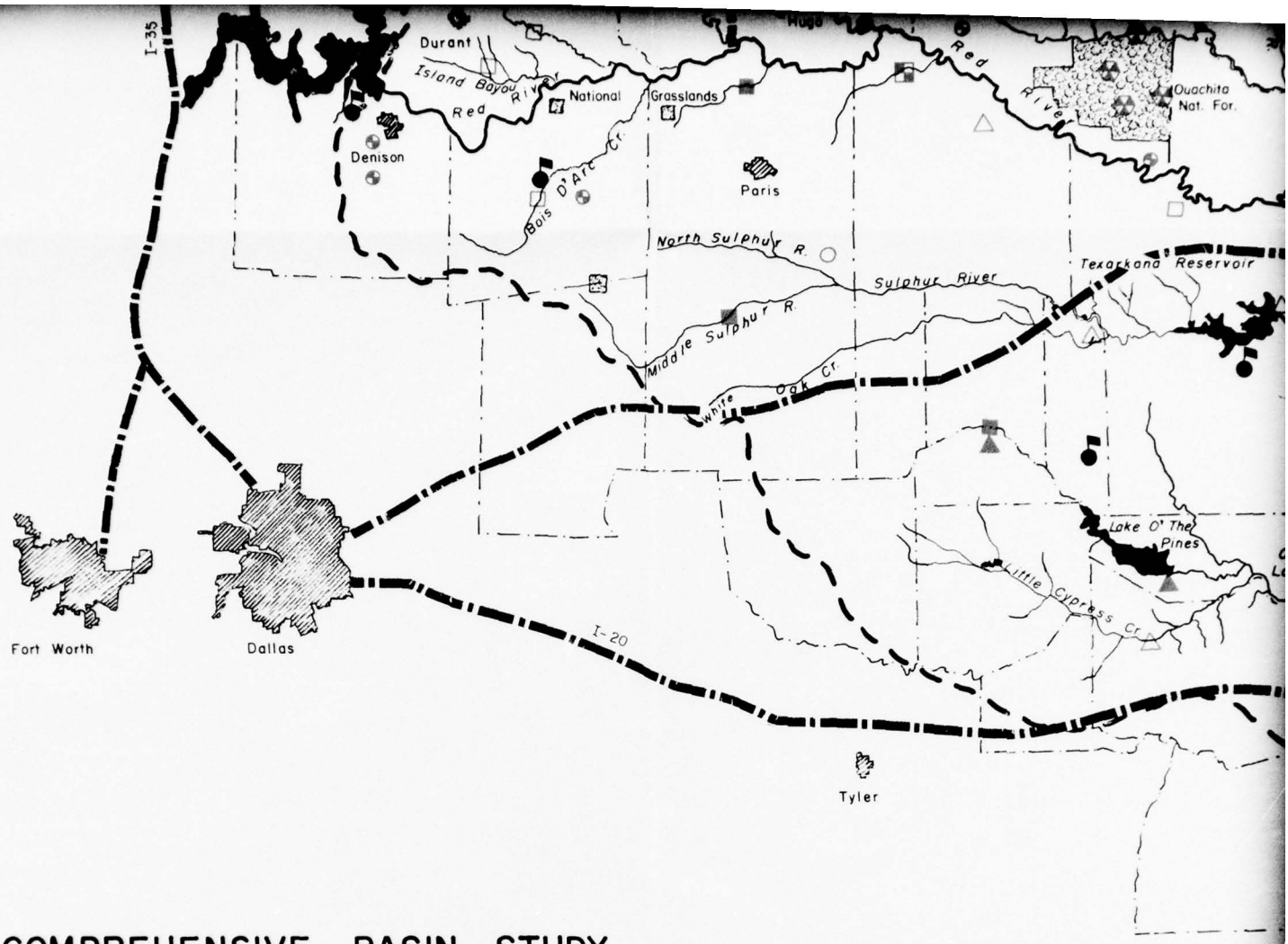

OKLAHOMA
21%
24%
14%
3%
3%
8%
ARKANSAS
TEXAS
16%
64%
33%
LOUISIANA
20%
9%
45%
RED RIVER BASIN
A Comparison of Percentages of Developed Recreation Acres, Annual Attendance and Population
% Developed Recreation Acres
% Annual Attendance
% Population



COMPREHENSIVE BASIN STUDY

RED RIVER BASIN


MAP 2
Fort Smith
Ouachita Nat. For.
Mena
Little Rock
Mountain Fork River
Rolling Fork
Cossatot R.
Saline River
I-30
Ouachita Nat. For.
OKLAHOMA
ARKANSAS
TEXAS
LOUISIANA
VICINITY MAP
Texarkana Reservoir
Texarkana
Magnolia
Lake Erling
Black Bayou
Bayou Bodcau Res.
Red River
Bayou Dorcheat
Kisatchie Nat. For.
Lake O' The Pines
Caddo Lake
Cypress Cr.
Cross Lake
Shreveport
Lake Bistineau
TAL PLAIN
Kisatchie Nat. For.



COMPREHENSIVE BASIN STUDY

RED RIVER BASIN

BELOW DENISON DAM

LOUISIANA, ARKANSAS, OKLAHOMA AND TEXAS

LEGEND:

- STATE BOUNDRIES
- STUDY AREA, COUNTY BOUNDRIES
- DRAINAGE BASIN

Scale in miles

10 0 10 20 30 40

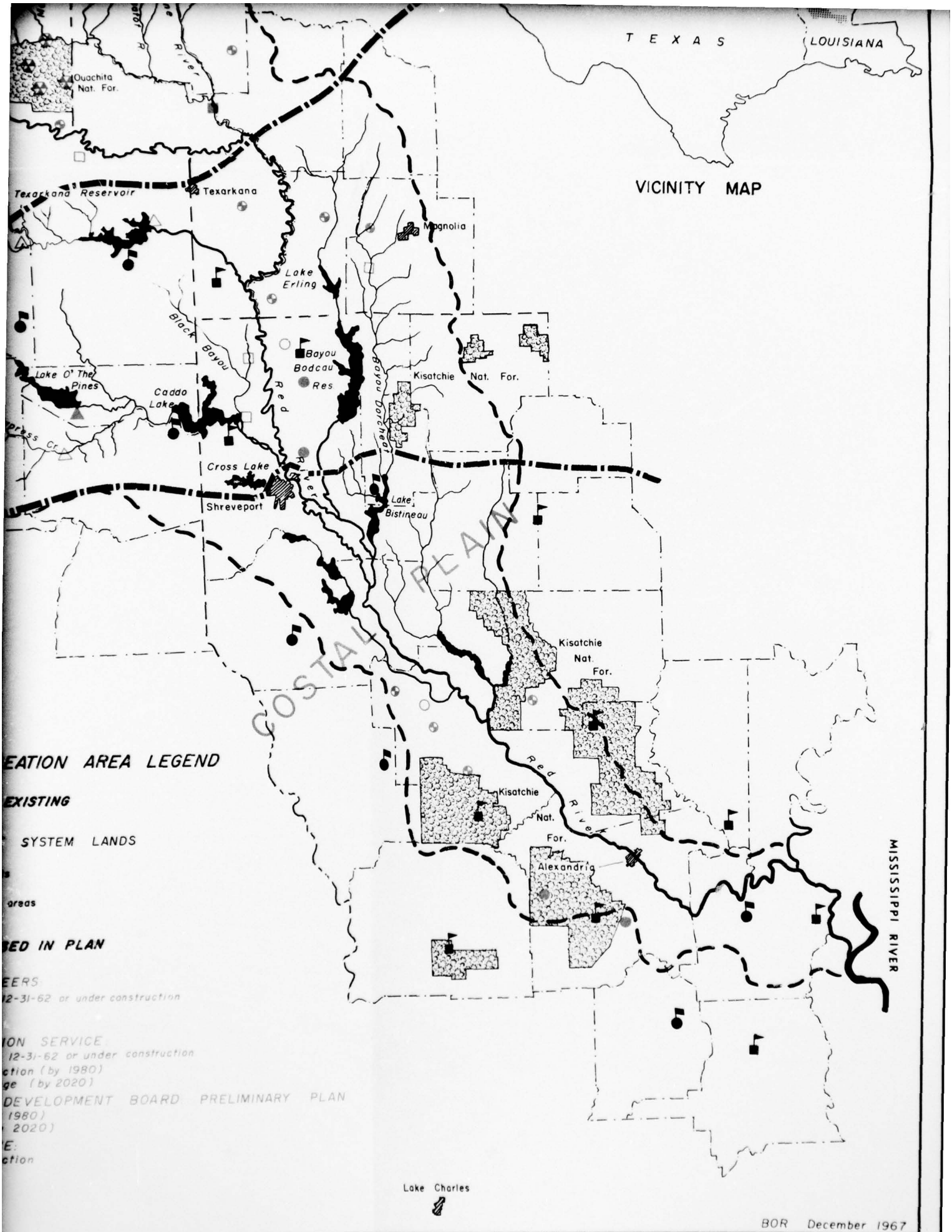
MAJOR RECREATION AREA L

EXISTING

- NATIONAL FOREST SYSTEM LANDS
- STATE
  - Parks and monuments
  - Recreation areas
  - Game Management areas

PROPOSED IN PLAN

- CORPS OF ENGINEERS
  - Constructed since 12-31-62 or under construc
  - Authorized
  - Proposed
- SOIL CONSERVATION SERVICE
  - Constructed since 12-31-62 or under const
  - Proposed early action (by 1980)
  - Proposed long-range (by 2020)
- TEXAS WATER DEVELOPMENT BO
  - Early action (by 1980)
  - Long-range (by 2020)
- FOREST SERVICE
  - Proposed early action



EATION AREA LEGEND

EXISTING

SYSTEM LANDS

areas

SED IN PLAN

EERS
12-31-62 or under construction

ION SERVICE
12-31-62 or under construction
ction (by 1980)
ge (by 2020)

DEVELOPMENT BOARD PRELIMINARY PLAN
1980)
2020)

E:
ction

RED RIVER BELOW DENISON DAM
ARKANSAS, LOUISIANA, OKLAHOMA, AND TEXAS
COMPREHENSIVE BASIN STUDY

APPENDIX XIII

FISH AND WILDLIFE

Prepared by
U. S. Department of the Interior
Fish and Wildlife Service
Bureau of Sport Fisheries and Wildlife

June 1968

APPENDIX XIII
FISH AND WILDLIFE

ABSTRACT

This report was prepared by the Bureau of Sport Fisheries and Wildlife with the assistance and concurrence of the other members of the Fish and Wildlife Work Group for the Comprehensive Study of the Red River Basin, Arkansas, Louisiana, Oklahoma, and Texas. The report presents estimates of demands, supplies, and needs for fish and wildlife resources and the opportunities provided in future years for sport fishing, hunting, intangible esthetics, and commercial fish production. An early action plan, recommended for implementation within the next 10-15 year period, is described and evaluated in terms of satisfying the needs and perpetuating a diversified supply of fish and wildlife resources for future years. Long-range planning, as a continuing process, is also considered as a function of the study.

APPENDIX XIII

FISH AND WILDLIFE

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TABLES

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FISH AND WILDLIFE

I. INTRODUCTION

A. Scope and Authority

This report presents the findings of the Fish and Wildlife Ad Hoc Interagency Work Group, established under the direction of the Red River Basin Coordinating Committee. It presents features of the Comprehensive Basin Study of the Red River below Denison Dam, Arkansas, Louisiana, Oklahoma, and Texas. Comprehensive planning for this basin represents an expansion of the study of Red River below Denison Dam, authorized by resolutions of the Committees on Public Works of the Senate and House of Representatives, adopted September 12, 1959, and February 24, 1960, respectively, and is in accordance with the basin planning concept of Senate Document No. 97. The scope of this study includes all water and related land-resource developments within the entire basin of the Red River below Denison Dam, excluding the Ouachita-Black River drainage (see plate 1).

B. Acknowledgements

The fish and wildlife study of this comprehensive project was undertaken as a cooperative endeavor of the fish and game departments of the States of Arkansas, Louisiana, Oklahoma, and Texas, and the Bureau of Sport Fisheries and Wildlife, in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). The Bureau's Southwest Region, with headquarters at Albuquerque, New Mexico, made studies of that portion of the basin above Fulton, Arkansas. The Southeast Region, with headquarters at Atlanta, Georgia, studied the lower basin and consolidated the respective regional reports. The Great Lakes and Central Region of the Bureau of Commercial Fisheries, Ann Arbor, Michigan, provided the section of the report on commercial fisheries.

C. Fish and Wildlife Study Objectives

The study presents a broad-scaled analysis of expected fish and wildlife populations and associated human demands for these natural resources within the study area. The Work Group's primary objective throughout this study has been to formulate realistic fish and wildlife planning that will provide for the development of these valuable natural resources and their associated utilization by fishermen and hunters.

II. DESCRIPTION OF THE BASIN

A. Physiographic Features

The Red River Basin, exclusive of the Ouachita-Black Basin, has a total drainage area of about 69,200 square miles. Drainage from the upper 39,700 square miles is controlled by Denison Dam on Red River near Denison, Texas. The 29,500 square miles of the basin considered in this study extends from Denison Dam downstream to the general vicinity of Avoyelles Parish, Louisiana. This lower segment of the Red River Basin is bounded on the north by the Arkansas River Basin, on the east by the Ouachita-Black Basin, and on the southwest by the Sabine River Basin. Plate 1 depicts the basin boundary and the counties and parishes involved in the study area.

The Red River below Denison Dam follows a meandering 726-mile course to its confluence with the Atchafalaya and Old Rivers. The upper reach of the river forms the boundary between Texas and Oklahoma, and Texas and Arkansas. At Fulton, Arkansas, the river turns abruptly southward some 77 miles to the Arkansas-Louisiana state line. The remainder of its course lies within the State of Louisiana.

Geographically, the project study area lies within two major physiographic provinces, the Ouachita Province in the north and the Coastal Plain Province of Louisiana and Texas in the south. Elevations range from a high of about 2,800 feet on the summits of several mountains in the Oklahoma portion of the study area, to a low of about 35 feet in the lower alluvial section of Louisiana.

The climate of the basin study area is mild, with average annual temperatures varying from about 60° F. in the west to about 67° F. in the east. Extreme temperatures from -22° F. to 118° F. have been recorded but are usually of short duration. Average annual rainfall ranges from 39 inches at Denison Dam to 57 inches at Alexandria, Louisiana.

Major tributaries of the Red River which are included in this study include Blue River, Boggy Creek, Kiamichi River, Little River, Sulphur River, Cypress Creek, Loggy Bayou, Bayou Pierre, Saline Bayou, and Cane River.

B. Populations

The 1960 population census indicated that approximately 1,200,000(1) persons lived in the study area, of which 77 percent were classed as urban and 56 percent, rural. There are two major urban centers in the basin, Shreveport-Bossier City, Louisiana (1960 population, 286,000) and Texarkana, Texas-Arkansas (1960 population, 67,000), both centrally located in the study area.

---

(1)Population based on basin drainage.

C. Economy as Related to Fish and Wildlife Resources

Agriculture is predominant throughout the basin area, with diversified farming being practiced in conjunction with livestock raising, dairying, and poultry farming. Major crops include fruits, vegetables, watermelons, cotton, corn, soybeans, small grain, and hay. Mineral production in the four-State study area consists principally of petroleum, natural gas, natural gas liquids, and iron ores. The timbered areas, located in northeast Texas, southeast Oklahoma, southwest Arkansas, and northwest and central Louisiana, provide lumber, pulp, piles, posts, poles, veneer, and cooperage.

III. FISH AND WILDLIFE RESOURCES AND USE

A. Existing Conditions

In 1960 the basin study area contained an estimated 17,563,000 acres of habitat considered suitable for wildlife production. This habitat is widely variable in quality throughout the basin. Extensive Red River bottom land forests of major importance to woodland wildlife remain in the study area, primarily in the complex backwater area below Alexandria, Louisiana. Upstream from Alexandria, smaller tracts of bottom land timber of moderate wildlife value persist on areas subject to frequent overflow or on accretion lands. Bottom lands of tributaries included within the study area are largely forested. Major hardwood species common to these bottom lands include bitter pecan, hackberry, ash, elm, sweetgum, and various red oaks.

The forested tributary bottoms make up the most valuable wildlife habitat in the basin study area, generally sustaining good populations of deer, squirrels, rabbits, and in certain areas, turkeys. Water fowl use of the main stem bottom is generally poor to occasionally moderate, depending on water stages during the fall-winter months. Tributary bottoms, however, are capable of providing excellent water fowl feeding areas when overflow conditions coincide with years of good mast production.

Upland forest habitat in this basin is primarily a pine or pine-hardwood association, made up of such species as loblolly, long-leaf and short-leaf pines, red and white oaks, beech, maple, and hickories. This forested upland habitat generally supports moderate to good populations of deer, squirrels, rabbits, and occasionally turkeys. A segment of the Texas and Oklahoma forested uplands comprises what is commonly known as the "Cross Timbers," a narrow band of low-quality blackjack oak-post oak. This area provides only moderate quality wildlife habitat.

Agricultural and pasture lands generally predominate land usage within the flood plain of the Red River, especially in that reach between Fulton, Arkansas, and Alexandria, Louisiana. Intensive agricultural developments in this area have drastically reduced forest wildlife populations, particularly where flood protection measures have lessened the dangers of overbank flooding.

Cleared lands in the upland areas of the basin are generally not as intensively developed as those along the Red River flood plain. In the past, significant acreages of upland were cleared for agricultural purposes, but poor soils and the general decline of small farms have altered the trend. It is estimated that in the future, large acreages of these cleared uplands will revert back to timber, primarily pine.

Parts of two national forests and one national grasslands are found in the study area. Approximately 220,000 acres of the Ouachita National Forest are located in Arkansas and Oklahoma, and 238,000 acres of the Kisatchie National Forest are contained in the Louisiana segment of the work area. The Panhandle National Grasslands is administered by the U. S. Forest Service, and approximately 18,000 acres are located in Fannin County, Texas. Plate 1 depicts the various segments of these forests and grasslands. These Federal lands are open to sport hunting and fishing, and annually receive moderate to heavy use, especially on Forest Service lands in Louisiana.

Military installations in the basin serve as excellent wildlife production areas, and several are open to limited public hunting. Military facilities include the Louisiana Ordnance Plan and Barksdale Air Force Base in Louisiana, and Red River Arsenal and Longhorn Ordnance Works in Texas. A significant acreage of several of these military installations is managed on a cooperative basis by State and military conservation personnel.

Scattered throughout the study area are State wildlife management and public hunting units. These facilities, on the whole, provide excellent wildlife habitat, and those open to hunting receive heavy use. Several of these management units are located on National forest lands. One is located on the U. S. Corps of Engineers Bodcau Reservoir project, and one is located on Texarkana Reservoir. Such units are managed by respective State game and fish agencies. A total of about 350,000 acres of State-managed wildlife lands are located in the basin. Plate 1 shows the locations of these units. Tables 1 through 4 list the existing wildlife facilities and developed installations located in the Red River Basin study area.

As is true with the wildlife environment of the study area, fish habitat is widely variable. The largest continuous water area in the basin, the Red River, receives light utilization, though there

is evidence that a fair game fish population is present. An important concentration of fishing effort occurs in the tailwaters of Denison Dam. Commercial fishing is important through all reaches of the main stem.

The tributary stream system of this lower basin of the Red River exhibits vast differences in habitat character. The most scenic section of the study area is the Ouachita Highlands of southeastern Oklahoma and southwestern Arkansas. Within this province are numerous mountain streams that support good populations of smallmouth bass. The Mountain Fork, the Upper Little River, the Rolling Fork, the Saline, and the Cossatot Rivers are the largest and best known smallmouth bass streams in the basin, and compare favorably with any mountain stream in the Southeastern United States. These streams receive considerable use, despite the rugged topography of the area.

Other tributary streams in the basin drainage generally provide moderate to high value sport fishing. Certain reaches of several streams are adversely affected by inadequate downstream releases from large reservoirs. Other stream reaches in the study area are polluted, and some have been channelized, either of which condition materially reduces the productivity of the aquatic habitat.

Natural lakes abound along the main stem of Red River, and as a whole, are very productive. Where flood protection measures have been constructed, many of these lakes no longer receive overflow from the Red River. Studies strongly indicate that productivity in these lakes declines as the frequency of overflow decreases. The complex backwater system below Alexandria contains many natural lakes that are extremely productive. The largest of these, Larto and Saline, are probably the finest natural fishing lakes in the basin study area.

Farm or stock ponds are abundant in the basin, and on the whole are fairly productive. Larger impoundments, including multiple-purpose Corps of Engineers reservoirs, supply the greatest acreage of water in the basin. Fish habitat in these impoundments varies greatly, but generally can be classed as moderately productive. Practically all of these reservoirs are centrally located in the basin, and all are rather intensively used. Plate 1 depicts the location of these reservoirs. Tables 5 through 8 summarize the existing fishery facilities for the four States of the study area.

Fishing and hunting activities are eagerly pursued by a significant portion of the basin's population. Much of this interest can be traced to the predominately rural character of the study area, and to its historical abundance of fish and wildlife resources. Prior to the turn of the century, the Red River Basin provided excellent habitat for deer, bear, wild turkey, waterfowl, and a

multitude of small game and fur animals. Present day hunting is directed at squirrels, rabbits, and doves, and where populations are high, deer. Most of the basin's hunting effort and a sizable percentage of the sport fishing effort is expended on privately-owned lands. Trapping of fur animals on a commercial basis has largely disappeared from most reaches of the Red River study area, due primarily to a general decline in fur prices. Sport trapping and fur hunting with dogs are popular throughout the basin. Plate 2 and table 9 give a summary of wildlife habitat in the project area for 1960 and future target years.

Sport fishing activities within the study area have historically been tied to natural lakes and streams. The appearance of the first large flood detention reservoir in the basin shortly after the turn of the century initiated a change in local fishing habits that is continuing today. Plate 3 shows 1960 through 2080 acreages of the various types of fishing water in the basin.

To realistically determine fishing and hunting supply for this comprehensive study, all land and water resources within the basin study area were inventoried by fish and wildlife habitat types and evaluated in terms of the man-days of fishing and hunting they were able to provide. These values were evolved from respective State game and fish agencies' files, field investigations, and population studies conducted on similar fish and wildlife habitat types in other basins. These sources of information yielded valuable data concerning sustained annual harvests, man-days expended per kill, and man-days of sport fishing per acre of various types of fishing water in the basin (see table 10).

Tables 25-28 indicate that the 1960 wildlife supply was equal to the 1960 hunting demand. These tabular data provide a working base for wildlife habitat from which planning activities could be developed.

Because wildlife populations are a product of habitat, change in this habitat base will cause corresponding changes in wildlife populations. Where such changes are detrimental to wildlife, and habitat is destroyed or adversely altered, wildlife resources are reduced; or, in similar manner, when habitat is increased or beneficially altered, wildlife resources are increased. Wildlife evaluations are based on this premise, and subsequent discussion in this report will show how wildlife needs develop with anticipated land use changes in the basin.

Since the use of wildlife resources is intimately related to land management, these resources are subject to, and influenced by, a variety of related legal, social, and economic factors. These factors include land posting, unequal distribution of supply and demand, intolerance to hunter crowding, slow acceptance of liberalized

hunting regulations, and hunter preference by type of hunting. To evaluate these resources, the Bureau has used an available wildlife supply level and a potential wildlife supply level of hunter use to demonstrate the value of wildlife resources in the basin.

The available supply level has been formulated by States for the various land resource areas in the basin. Available supply levels recognize that some wildlife habitat is not open to hunting; other habitat is located in areas of low human populations and, subsequently, receives much less hunting pressure than it is capable of supporting. In some localities wildlife populations are underharvested because of legal restrictions, and in still other situations, hunters are unwilling to adopt different hunting methods which would permit the utilization of portions of the resource still untapped. These are but a few of the factors which contribute to a reduced level of resource use. Average man-day use for the various types of wildlife habitat at the available level of supply are given in table 11.

Potential supply level can be defined as that level of hunting which could be expected if the restrictions discussed in the above paragraph were remedied while still maintaining harvest standards that provide high quality recreation, and at the same time the resource to maintain itself. It is from this potential supply base that future wildlife needs in this basin can be at least partially satisfied through resource planning.

The basin study area in 1960 contained a total of approximately 17,730,300 acres of habitat suitable for wildlife production. This acreage is potentially capable of supplying nearly 4,000,000 man-days of hunting opportunities annually. It is estimated that only 1,929,000 man-days of this potential were utilized for hunting in 1960, due to the restrictions on use of wildlife resources as described in this report. Tables 12-15 give the existing and projected acreage of wildlife habitat and supply.

Sport fishery resources have been evaluated on a potential supply basis by types of fish habitat. The term "potential supply," as used in this report, denotes a realiable level of fishing which could be reasonably achieved if the various types of fish habitat in the basin were managed. Legal and socio-economic restrictions to sport fishing activities are not considered to be as important as is the case with hunting.

The 1960 inventory of fishery habitat in the study area totaled approximately 305,225 surface acres capable of supporting an estimated 4,924,100 man-days of fishing. Impoundments accounted for 56 percent of the total fishing area in the basin, and 52 percent of the potential man-day supply to satisfy fishing demand. Calculations of fishing supply are based on biological productivity and creel

acceptability standards which are judged realistic for this basin. Tables 16-19 show the existing and projected acreage of water types and man-day supply of fishing for 1960 through 2080.

Fishing and hunting demand is directly related to human populations, and can, therefore, be estimated from established population data. The percent of hunters and fishermen within the basin study area was determined by utilizing information contained in the 1960 National Fishing and Hunting Survey, and in ORRRC Study Report 7, Sport Fishing Today and Tomorrow. The resident demand for fish and wildlife resources in 1960, by respective States, is presented in tables 20 and 21. Changes indicated in the 1965 National Fishing and Hunting Survey were not considered to be significant enough to warrant the revising of fishing and hunting participation data, and the 1960 base was not updated.

Opportunities for scientific and nature study in the scenic environment inhabited by wildlife resources in several areas of the basin provide incentive for bird watching and wildlife photography. These opportunities are expected to increase as a result of proposed reservoir developments in the basin, especially in Oklahoma. Small populations of several endangered species of American wildlife are reported to exist in the more remote sections of the Red River Basin study area. These endangered species are the red wolf and the American alligator. The southern bald eagle, also listed on the Department of the Interior's endangered species list, is infrequently found in the wooded portions of the basin.

The red wolf is reported to be found in small numbers in the larger tracts of bottom land timber. Partly because of the accelerated destruction of its bottom land habitat by drainage and land clearing practices, this species faces virtual extinction in the Red River Basin. The American alligator is found in isolated water areas of the Louisiana and Arkansas portion of the basin. The privately owned Grassy Lake area in Hempstead County, Arkansas, is a prime wilderness area for this animal, as well as numerous other species of wildlife. The southern bald eagle's breeding range includes the lower Red River drainage. Once fairly common throughout the Southern United States during the winter months, this majestic bird is fast yielding to man's encroachment into wilderness areas and also to modern agricultural practices.

The existing and projected demands for commercial-fishery products in the Red River Basin were developed from current data provided by the Bureau of Commercial Fisheries. Demand projections are based on basin population increases and adjusted per capita use. Harvest records for commercial fishery products covering the period 1958 through 1962 are presented in table 22. These data indicate a general decline in harvest of the more important commercial species in the Red River Basin. Table 23 depicts existing commercial fishery habitat and related harvest potential.

B. Future Resources and Demand

Significant land use change trends within this basin have been in evidence in recent years. The most dramatic example of such change is shown in the accelerated conversion of large tracts of bottom land hardwood to agricultural lands. This conversion is especially true in the lower reaches of the study area where vast tracts are being cleared for soybean production. A less dramatic process is the reverting of former upland agricultural lands to large tracts of managed pine for timber and pulp production. Projections of land use changes to the various target years have been made by the Economic Research Service and the U. S. Forest Service. General basinwide trends indicate an increase in pasture-range lands, and decreases in forest and cropland (see plate 2). These predicted changes, however, vary somewhat from one State to the next.

The supply of sport fish habitat in the basin is expected to increase markedly in future years. Most of this increase can be attributed to large reservoir construction (see plate 3). Additional increases are anticipated in new farmponds and small floodwater retarding structures. On the other hand, small and large reservoir construction projects will further deplete the already short supply of quality stream fish habitat in the basin. This will be especially true in Oklahoma and Arkansas, where smallmouth bass streams are now at a premium.

Population projections as furnished for the Red River Basin study area clearly show a significant increase in human population throughout project life (table 24). Practically all of this increase can be attributed to continued urban growth throughout the basin, while rural populations are predicted to decline. Expected expansion of many of the basin's present industries and the development of new plants and manufacturing centers will contribute to this increase in basin population through the creation of new job opportunities.

This ever-expanding human population base will create a corresponding increase in fishing and hunting interest and participation. The effects of this increase will be felt primarily around the large urban centers, but improved modes of transportation and more leisure time will make it even more feasible for fishermen and hunters to travel increasingly farther from their places of residence. Although State lines will probably continue to exert a controlling and restrictive influence on most of the basin's hunting and fishing population, it appears likely that all reaches of the basin study area will become readily accessible in the foreseeable future.

It is predicted that demand for commercial fishery products for both human consumption and industrial usage will increase in future years. The recent decline in fresh water commercial production

in the Red River Basin (see table 22) is not thought to be a significant indication of future production. The decline in catch of certain important commercial species may well be related to the relatively heavy organic and inorganic pollution load the Red River carries. The potential benefits to the resource from water quality improvement are beyond the scope of this report, but when such improvements are initiated, it is expected that commercial catches will increase. The construction of proposed and authorized large reservoirs in the basin will add significantly to the commercial fish production of the area. Our demand predictions of per capita consumption for the various target years appear to be reasonable and indicate that commercial food fish harvests will be capable of supplying the needs of the basin.

C. Fish and Wildlife Resource Needs

Existing and projected needs for fishing and hunting within the basin study area were determined by a direct comparison of the demand for and the supply of these resources.

The potential supply level of hunting in the basin is significantly greater than the available level. As pointed out earlier in this report, an assumption was made that there was no unsatisfied demand in the basin in 1960. As predictions of land use changes become evident, however, certain available level needs appear throughout the basin. Although each of the four States represented in this study exhibits these needs, our calculations indicate that the Louisiana segment will be faced with a definite problem by the year 2000. At this time, Louisiana resident hunting demand will surpass even the potential ability of the habitat to furnish quality hunting. By the end of project life (2080), the Arkansas portion of the basin study area will face a similar situation. Tables 25 through 28 depict existing and projected hunting supply and demand relationships for the various target years and resulting "needs" at the available and potential levels of supply.

Our investigations into sport fishery needs in the basin showed a wide dispersion of demand versus supply factors. Pressing needs exist in Texas for all types of fishing, and projections indicate that these needs will become greater in future years. Louisiana presently has adequate fishing waters to satisfy its resident demand, but by 1980 it too will be faced with needs for all classes of sport fishing. Arkansas and Oklahoma have ample supplies of all classes of fishing water except streams, where needs are anticipated after the year 1980. The existing and projected needs for fishing, as determined by the comparison of demand for and supply of fishery resources are shown in tables 29 through 32.

D. Commercial Fishery Resource Needs

Based on nationwide per capita consumption figures for domestic fresh water fish produced outside of the Great Lakes, demand

originating within the Red River Basin in 1960 is estimated at 496,000 pounds. This includes intrabasin demand for both edible and industrial fresh water fishery products. Projected increases in per capita consumption of domestic fishery products indicate that demand originating within the basin will be 2,537,000 pounds by 2020. Assuming no further increase in per capita consumption thereafter, estimated demand in 2070 will be 4,209,000 pounds. Between 2020 and 2080, internal demand will exceed average annual production of the base period 1958-1962. In terms of potential productivity of commercial fishery habitat in the basin, internal demand in 2080 represents 53 percent of capacity.

This analysis of demand-supply relationship is solely restricted to a consideration of internal basin demand due to the lack of a satisfactory methodology to calculate interbasin tradeoffs. In the Red River Basin, the bulk of the commercial fish catch is probably distributed outside the basin. Nevertheless, an analysis of the purely internal situation is helpful in terms of obtaining a partially quantified framework for planning purposes.

Currently, production exceeds intrabasin demand by some 2,500,000 pounds. However, the Red River Basin does not appear to have any particular advantage relative to other areas in the production of the traditional fresh water commercial fishery products. As the commercial fisheries of other basins (not now meeting internal demands) develop in the future, curtailment of exports from the Red Basin with gearing of production to internal needs only is a possibility that must be considered.

Although the Red Basin does not appear to have any intrinsic advantages from the standpoint of producing traditional food fish items, this does not necessarily hold for the potential for utilizing various nonfood species in the production of fishmeal. Fish population studies have indicated that in general the impoundments of the Arkansas-White-Red and Tennessee Basins have the greatest potential for fishmeal production of midwestern inland waters. Gizzard shad is the primary species available for utilization.

The most likely consumer of fishmeal produced in the Red Basin is the poultry food industry of Arkansas and surrounding areas. In 1966, some 144 million pounds of meal were consumed by this industry and future use is expected to increase to 297 million pounds by 1975. The raw fish requirements for these quantities of meal are approximately 790 million pounds and 1.6 billion pounds, respectively.

At the present time, all of the fishmeal produced for poultry feed is derived from marine sources. It appears, however, there would be no objections to using fresh water fish providing the product is competitively priced and meets the analysis of marine

meal, and if feed manufacturers can be assured of adequate supplies in advance of actual production needs.

In summary, the basin's commercial fishery resource base appears to be capable of meeting intrabasin demands for fresh water commercial fishery products throughout the study period. However, a portion of the resource base is also capable of providing fish for interbasin demands of industrial fishery products, chiefly fishmeal for the poultry feed industry.

IV. COMPREHENSIVE PLAN OF DEVELOPMENT

A. Early-Action Projects (10- to 15-year plan)

1. Corps of Engineers Projects

The Corps of Engineers 10- to 15-year plan of development includes the construction or enlargement of 11 reservoirs and 1 pump-storage project in the basin study area. Four of the sites are in the New Orleans Corps of Engineers District and 8 in the Tulsa District. Three local protection projects are also proposed for the New Orleans District (see plate 4). Red River navigation and bank stabilization features have been reported on in a Bureau report dated January 5, 1965.

The Corps early-action projects are summarized below by Corps of Engineers District:

a. New Orleans District, Corps of Engineers

Titus County Reservoir, Texas. Conservation pool - 12,200 acres. Multiple-purpose reservoir located on Cypress Creek, southwest of Mt. Pleasant, Texas, for water supply and recreation.

Caddo Lake, Louisiana and Texas. (Enlargement) Conservation pool - 8,600 acres. Enlargement of existing Caddo Lake for water supply, and recreation.

Kisatchie Reservoir, Louisiana. Conservation pool - 9,180 acres. Multiple-purpose reservoir located at mile 5.7 on Kisatchie Bayou for irrigation, water supply, flood control, and recreation.

Dorcheat Reservoir, Arkansas. Conservation pool - 17,300 acres. Multiple-purpose reservoir located at mile 105 on Bayou Dorcheat for water supply, water quality control, and recreation.

Posten Bayou, Arkansas. Local protection project consisting of channel excavation, levee construction, and a water control structure.

McKinney Bayou, Arkansas. Local protection project consisting of channel enlargement and two water control structures.

Days Creek, Arkansas and Texas. Local protection project providing for channel enlargement and drainage.

The proposed navigation and bank stabilization features of the Red River below Denison Dam project are expected to be in place by 1980. The project will provide the following developments pertinent to fish and wildlife:

Arkansas: Ten main stem bendway cutoff lakes with one access site on each lake.

Louisiana: Twenty-one access sites on Red River main stem, one access site on Twelvemile Bayou, and 28 bendway cutoff lakes with 31 related access sites.

Oklahoma: Four main stem bendway cutoff lakes with one access site on each lake.

Texas: Two access sites on Cypress Creek and one bendway lake with one access site.

b. Tulsa District, Corps of Engineers

Durant Reservoir, Oklahoma. A multiple-purpose reservoir for flood control, water supply, recreation, and fish and wildlife located in the lower Blue River Basin. Conservation pool - 8,980 acres.

Albany Reservoir, Oklahoma. A multiple-purpose reservoir, including flood control, water supply, recreation, and fish and wildlife located on lower Island Bayou. Conservation pool - 4,960 acres.

Parker Reservoir, Oklahoma. A multiple-purpose reservoir, including flood control, water supply, recreation, and fish and wildlife located in the upper Muddy Boggy Creek Basin. Conservation pool - 6,110 acres.

Bonham Reservoir, Texas. A multiple-purpose reservoir for flood control, water supply, recreation, and fish and wildlife located in the upper part of Bois d' Arc Basin. Conservation pool - 5,280 acres.

Liberty Hill Reservoir, Texas. A multiple-purpose reservoir for water supply, recreation, and fish and wildlife, to be located on Mud Creek near New Boston, Texas. Conservation pool - 7,070 acres.

Tuskahoma Pump-Storage Hydropower Project, Oklahoma. The authorized Tuskahoma Dam would be raised 2.5 feet and the reservoir would be used as the afterbay. An additional 1,800 acres of land would be required in the authorized project. Forebay pool - 590 acres.

Sherwood Pump-Storage Project, Oklahoma. A multiple-purpose reservoir for power, flood control, recreation, and fish and wildlife development. Located on Mountain Fork River immediately upstream from Broken Bow Reservoir. Power pool - 32,300 acres.

McGee Creek Reservoir, Oklahoma. A multiple-purpose reservoir for flood control, water supply, recreation, and fish and wildlife. Conservation pool - 3,500 acres.

Additional large reservoir projects located in the Tulsa Corps of Engineers District include Pat Mayse and Millwood which are in operation; Gillham, De Queen, Dierks, Broken Bow, Pine Creek, and Hugo under construction; and Lukfata, Tuskahoma, Clayton, Boswell, and Big Pine which are authorized for construction. All of these projects are expected to be in place by 1980. The increased supply of large impoundments is reflected in tables 29, 31, and 32. In conjunction with Hugo Reservoir, the Bureau is planning a 17,700-acre national wildlife refuge within the Corps of Engineers acquisition proposal.

2. Soil Conservation Service Projects

The Soil Conservation Service plan proposed for action within the next 10 to 15 years includes the development of 52 watersheds in the 4 States of the study area (see plate 4). Thirteen P. L. 566 watersheds are now authorized and will be constructed within this period. The following tabulation provides summary data on the Soil Conservation Service projects, by States.

a. Arkansas

The 7 watersheds proposed for early-action watershed developments in Arkansas will provide, in addition to other features, construction of 597 acres of multiple-purpose recreation reservoirs, 550 acres of single-purpose recreation reservoirs, and 3,275 acres of other single- and multiple-purpose reservoirs. Anticipated land clearing of 9,800 acres and 260 miles of channel works are estimated.

b. Louisiana

Four authorized 566 projects and 19 early-action watershed developments are expected to provide 7,223 acres of multiple-purpose recreation reservoirs, 2,040 acres of single-purpose recreation reservoirs, and 10,167 acres of other single- and multiple-purpose reservoirs. Anticipated land clearing is estimated to be 20,500 acres, with 894 miles of channel works.

c. Oklahoma

Six authorized 566 projects and 12 early-action watershed plans will allow for the construction of 780 acres of multiple-purpose recreation reservoirs, 480 acres of single-purpose recreation reservoirs, and 10,370 acres of other single- and multiple-purpose reservoirs. Anticipated land clearing is 14,700 acres; channel works, 167 miles.

d. Texas

Three authorized 566 projects and 14 early-action watersheds will provide for the construction of 1,042 acres of multiple-purpose recreation reservoirs and 9,303 acres of other single- and multiple-purpose reservoirs. Anticipated land clearing amounts to 4,000 acres, with 159 miles of channel works.

3. U. S. Forest Service Projects

National Forest System lands are a significant portion of all public lands in the Red River Basin. These lands provide excellent opportunities for hunting, fishing, and other recreational uses. Future developments on these lands pertinent to fish and wildlife include land acquisition, stream preservation, construction of recreation

lakes, and access-road development. U. S. Forest Service plans for early-action are summarized by States as follows:

a. Arkansas

Plans call for the construction of 140 acres of recreation lakes, 3 access sites, and 2.5 miles of roads specifically for access to new recreational areas.

b. Louisiana

Developments consist of 13 miles of stream preservation, 2,003 acres of recreation lakes, 6 access sites, and 7 miles of roads specifically for access to new recreational areas.

c. Oklahoma

The proposed plan includes land acquisition of 13,765 acres, a 45-acre recreation lake, 515 acres of "green-tree" reservoirs, 8 access sites, and 7.5 miles of roads to new recreational areas.

d. Texas

Forest Service plans include the renovation of dams on two recreational lakes and rehabilitation of one recreation area. No new construction is planned.

B. Effects of Early-Action Projects on Fish and Wildlife

Early-action projects proposed by the Corps of Engineers and Soil Conservation Service will provide a significant increase in the supply of impoundment-type fish habitat. Sport fishing use of this resource, however, is predicted to be only moderate because of limitations on demand for this type of fishing. Commercial food fish resource supplies will be markedly increased by large reservoir projects. Stream fishery losses will result from stream habitat inundation by reservoirs, downstream water quality degradation, and damage to stream segments by proposed channelization works. Proposed projects and effects on sport and commercial fishing are given in tables 33, 34, and 35.

Wildlife losses and benefits will result from Corps of Engineers and SCS early-action projects. Wildlife benefits in the form of waterfowl, upland-game, and big-game hunting will accrue to proposed reservoir developments and to land treatment measures in upstream watershed projects. Wildlife values will be further defined

when detailed project investigations are made. A summary of projects and anticipated effects on wildlife are given in tables 36 and 37.

C. Long-Range Water Resource Planning

Water resource developments proposed for long-range considerations include 12 Corps of Engineers reservoirs, the modification of 13 existing and authorized reservoir projects, 14 local protection projects, and the development of 43 watersheds under Public Law 566 planning. Long-range plans for the basin will include consideration of reservoir projects proposed in the Texas Water Development Plan.

D. Effects of Long-Range Plan on Fish and Wildlife

Reservoir construction and watershed developments will conflict in many cases with early-action fish and wildlife planning features. Construction of these reservoir projects will inundate valuable stream fish habitat and also destroy or alter extensive acreages of bottom land hardwood wildlife habitat.

V. FISH AND WILDLIFE PLANNING

A. Early-Action Planning (10 to 15 years)

The proposed early-action plan of development for fish and wildlife in the Red River Basin is a result of the coordinated efforts of members of the Fish and Wildlife Ad Hoc Work Group. The plan as presented strives to approach the potential level of fishing and hunting through single- and multiple-purpose fish and wildlife measures. Means of implementing plan developments will vary, depending on the item or agency involved. Existing congressional acts that provide assistance in this area are listed in table 39. A summary of the demand-supply relationship of fish and wildlife resources in 1960, the anticipated change by 1980, and proposals for meeting needs are described by States.

1. Arkansas

As described earlier in this report, the 1960 available supply of hunting was assumed to be equal to the hunting demand in all States of the study area, including Arkansas. By 1980, Arkansas will exhibit needs for hunting at the available level of supply (table 25). The supply of fishing waters in 1960 was adequate to meet the demand in the Arkansas portion of the basin. It is anticipated that the Red River drainage in Arkansas will develop needs for stream fishing by the year 2000, stream and impoundment fishing by 2030, and all types of fishing by 2080 (table 29). Localized fishing and hunting needs are expected in the future.

a. State Plan for Meeting Future Fish and Wildlife Needs

Stream preservation:

Stream preservation proposals include: Approximately 15 miles of the Mountain Fork River in Polk County; an estimated 60 miles of the Upper Cossatot River upstream from Gillham Lake; a 20-mile reach of the Upper Little River upstream from Millwood Reservoir; 25 miles of the Saline River above Dierks Reservoir; about 25 miles of the Rolling Fork River above De Queen Reservoir; approximately 17 miles of Bayou Bodcau; and about 15 miles of Bayou Dorcheat.

Access developments:

Access planning for streams recommended for preservation in Arkansas has not been considered in this report. The degree of development will depend on the stream reach involved; certain reaches may require facilities for intensive use, while other sections will provide for only limited use in order to preserve natural environmental conditions.

Stream access development proposals on the Red River main stem include: One site of at least 2 acres located north of Texarkana at Highway 1 crossing at Index Bridge; a second site at the Fulton Bridge on Highway 67 northeast of Texarkana; and a third site at the Garland City Bridge on Highway 82 crossing at Garland City. Additionally, two areas of at least 2 acres per site should be developed on the Little River. Also, two areas of at least 2 acres each should be developed on the Cossatot River upstream from Gillham Lake and one site of 2 acres should be located at the Highway 70 crossing downstream from Gillham Dam. It is also suggested that one site of about 2 acres be located at the Highway 71 crossing near Touhe, in Miller County.

Releases for downstream fish and wildlife:

Studies should be made to determine whether water released from Millwood Reservoir could rejuvenate the Grassy Lake area to its former condition. If

investigations indicate that introduction of river water would prove beneficial, plans should be developed that would utilize reservoir storage for introduction purposes, especially during critical dry periods.

Plans for releasing at least 200 c.f.s. from Texarkana Reservoir should also be developed. These releases would benefit downstream fish and wildlife, and would provide the Arkansas Game and Fish Commission with sufficient water to manage the Sulphur River Game Management Area in Miller County.

Wildlife habitat acquisition:

Priority should be given to acquiring 1,000 acres in Sevier County and 1,000 acres in Howard County adjacent to Millwood Reservoir. This acreage would be developed for both big game and upland game management and hunting. It is suggested that about 2,000 acres of land adjoining the north boundary of the Bois d' Arc Game Management Area be acquired and added to this game management area. It is also suggested that the 30,000 acres of land located inside the Corps of Engineers flood easement along the Sulphur River be made available for wildlife management and public hunting.

Public access to wildlife areas:

All-weather roads should be constructed to developed and managed areas. The proposal to bring flood easement lands along the Sulphur River under management for public hunting should consider six access sites.

Preservation of unique wildlife habitat:

It is suggested that measures be instituted to preserve the "shut-ins" area on the Upper Cossatot River and the Grassy Lake site in Hempstead County.

b. Suggested Ways of Implementing Fish and Wildlife Plan

Stream preservation:

Means of preserving streams or select reaches of streams would require that adjacent lands be

purchased or leased. Acquisition would take the form of scenic easements or fee ownership. It is envisioned that fee ownership would be primarily at access points. The acquisition of necessary lands may involve joint Federal-State participation with respect to both administration and funding. Each stream must be evaluated separately to determine the most feasible solution to these requirements. Estimated costs and benefits for 177 miles of stream preservation in Arkansas are as follows:

Costs:

Initial costs - $212,000
Annual O&M - $22,000

Benefits:(2)

Annual man-days of fishing - 90,000
Annual value of above man-days - $180,000

Stream access development:

Acquisition of land for access developments on the Red River main stem and Sulphur River would be in fee title ownership. Lands and related facilities could be developed under existing Federal cost-sharing assistance programs.

Costs:

Initial costs - $75,000
Annual O&M - $5,000

Benefits:(3)

Annual man-days of fishing - 65,000
Annual value of above man-days - $65,000

Releases for downstream fish and wildlife:

Restoration and maintenance of the Grassy Lake area through introduction of river water from Little River would be a State responsibility, with Federal cost-sharing assistance available. The esthetic qualities of the area and also its value to fish and wildlife production, including

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(2)Stream fishery benefits established at $2 per man-day for cool water fish habitat.

(3)Benefits established at $1 per man-day for warm water streams and rivers.

an endangered species (the American alligator), justify costs involved.

Costs associated with additional releases from Texarkana Reservoir would be the responsibility of the Corps of Engineers.

Public fishing lake needs:

The proposed Dorcheat Reservoir in Columbia County and the Red River bendway cutoff in Miller County will tend to satisfy the need for public fishing lakes in these counties.

Proposed bendway lake developments by the Corps of Engineers in Arkansas will provide approximately 70,000 man-days of fishing valued at $70,000 annually. The proposed Dorcheat Reservoir will provide 69,000 man-days of sport fishing valued at $69,000.

Wildlife habitat acquisition:

Development of the three wildlife areas proposed in Arkansas would be the responsibility of the State, with Federal aid as available. Costs and benefits are as follows:

Millwood Area (2,000 acres)

Costs:

Initial costs - $200,000
Annual O&M - $2,000

Benefits: (primarily to upland-game and big-game hunting)

Annual man-days of hunting - 2,000
Annual value of above man-days - $6,000

Bois d' Arc Area Enlargement (2,000 acres)

Costs:

Initial costs - $150,000
Annual O&M - $1,500

Benefits: (primarily to upland-game hunting)

Annual man-days of hunting - 2,000
Annual value of above man-days - $4,000

Sulphur River Area (30,000 acres)

Costs:

Initial costs - $2,000,000
Annual O&M - $10,000

Benefits: (primarily to waterfowl hunting)

Annual man-days of hunting - 30,000
Annual value of above man-days - $90,000

Public access to wildlife areas:

The costs and benefits of access developments are a part of the overall development of new wildlife areas.

Preservation of unique wildlife habitat:

Where not affected by proposed construction projects, the State should be responsible for maintaining these areas. Maintenance of the "shut-ins" and Grassy Lake areas should be a State responsibility in conjunction with Federal cost-sharing provisions.

Preservation of the "shut-ins" area would be partly accomplished by stream preservation plans for the Upper Cossatot River. The preservation of these two areas would provide future generations with at least a glimpse of virgin wilderness habitat. Preservation would be justified on the basis of intrinsic esthetic values these sites possess. The use of these areas for fish and wildlife production would also be significant, particularily Grassy Lake.

c. Effect of Proposed Federal Projects on Fish and Wildlife

Based on current project data, Corps of Engineers and Soil Conservation Service water resource projects in the Arkansas portion of the basin will result in benefits to sport and commercial fishing, and losses to stream habitat and bottom land hardwood wildlife habitat.

Fish and wildlife benefits and losses resulting from the Red River bank stabilization plan, the

construction of the Dorcheat Reservoir, Posten Bayou, and McKinney Bayou local protection projects, and seven watershed developments are summarized as follows:

Corps of Engineers (tables 33, 35, and 36)

Fishery benefits - 70,000 man-days of sport fishing; $64,800 commercial fishery value.
Fishery losses - 1,300 man-days
Wildlife losses - 9,600 man-days
Wildlife benefits - 1,700 man-days

Soil Conservation Service (tables 34 and 37)

Fishery benefits - 19,800 man-days
Fishery losses - 500 man-days
Wildlife benefits - 500 man-days
Wildlife losses - 3,700 man-days

U. S. Forest Service

Fishery benefits - 2,100 man-days on 140 acres of recreation lakes

Preliminary studies indicate that wildlife losses resulting from the Red River bank stabilization feature and the Dorcheat Reservoir project could be mitigated through the development of wildlife facilities on 2,000 acres of land acquired by the project for mitigating purposes in the Sulphur River bottoms in Miller County. These lands would be developed primarily for waterfowl management and public hunting and turned over to the Arkansas Game and Fish Commission. Estimated costs and benefits of this plan of mitigation are presented below. All costs are considered a project expense.

Land Acquisition - 2,000 acres	$200,000
Developments	
Diking - 1,800-acre "greentree" reservoir	27,000
Water control structures	1,200
Pumps	10,000
Total	$238,200

Annual Charge		$ 8,100
Operation and Maintenance		5,700
Benefits		
1,800 acres managed for waterfowl hunting	3,600 M.D. -	$ 14,400
2,000 acres general wildlife-oriented recreation	1,000 M.D. -	500
2,000 acres general upland game hunting	800 M.D. -	1,600
		$ 16,500

Wildlife losses resulting from the McKinney and Posten Bayou local protection projects could be compensated for by project acquisition of 350 acres in the Sulphur River bottoms adjacent to the State-owned and managed Sulphur River Game Management Area. These lands would be intensively developed and managed for waterfowl and upland game hunting. Developments would consist of the diking and seasonal flooding of about 350 acres of bottom land hardwood. Estimated costs and benefits of this plan are presented below. All costs are considered to be a project expense.

Land Acquisition - 350 acres		$ 35,000
Developments		
Diking - 300-acre "greentree" reservoir		5,300
Water control structure		600
Pump station		5,000
Total		$ 45,900
Annual Charge		$ 1,550
Operation and Maintenance		950
Benefits		
300 acres managed for waterfowl hunting	600 M.D. -	$ 2,400
350 acres managed for general hunting	140 M.D. -	280
350 acres general wildlife-oriented recreation	175 M.D. -	80
		$ 2,760

Wildlife losses associated with Soil Conservation Service projects in Arkansas will be compensated to some degree by normal watershed improvement practices. Design features, such as crest control gates for wildlife management, if included in project planning, would also contribute to the mitigation of project-occasioned losses. In view of the number of flood detention and single- and multiple-purpose structures included in early-action planning, means of compensating for fish and wildlife losses should be determined as each respective watershed is studied in detail.

Losses to downstream fish and wildlife, beyond those tabulated below, will occur if adequate releases of water from reservoirs are not included in project planning. Regulated outflow should, in general, not be less than natural average minimum monthly streamflow for that month of the year. Such regulated flows should approximate the natural runoff cycle and will tend to preserve downstream fish and wildlife resources.

2. Louisiana

The Louisiana portion of the basin study area will exhibit hunting needs at the available level of supply by 1980 (table 26). There will also be needs for all types of fishing water in Louisiana by 1980 (table 30). It is recognized that localized fishing and hunting needs, not reflected in the State totals, may occur in certain areas of the State.

a. State Plan for Meeting Future Fish and Wildlife Needs

Stream preservation proposals include:

Approximately 60 miles of Saline Bayou in Bienville, Winn, and Natchitoches Parishes; an estimated 40 miles of Bayou Bodcau from the Arkansas-Louisiana state line downstream to the existing Bodcau damsite; 40 miles of Bayou Dorcheat above Lake Bistineau in Webster Parish; and about 70 miles of Black Lake Bayou above Black Lake.

Stream access developments:

Access planning for streams recommended for preservation includes 6 sites along Saline Bayou,

4 sites on Bayou Bodcau, 4 sites along Bayou Dorcheat, and 7 sites along Black Lake Bayou. Additional developments needed in the Louisiana portion of the basin include 1 access site below proposed Lock and Dam 1 on the Red River, 1 site on Big Creek (Rapides Parish side), 2 sites on Big Saline Bayou (Rapides Parish side), 1 site below Lake Bistineau on Bayou Dorcheat, 1 access site on Bayou Boeuf, 2 developments on the Catahoula Lake Diversion Channel at existing highway crossings, 1 site on Flat River in Bossier Parish, 1 site on Red Chute Bayou in Bossier Parish, 1 site on Twelvemile Bayou at the Dixie-Blanchard road crossing, and 4 access sites at proposed Lock and Dam 6 near Shreveport.

Lake and reservoir access developments:

Planning for public access should include 1 site at Teague Lake on Bayou Bodcau, 1 site on Wallace Lake, 1 development at Grassy Lake, 1 site at five of the small lakes along Red River just below Pineville, 2 sites at Larto Lake, 4 sites at proposed Lock and Dam 6 near Shreveport, 5 sites at Cotile Lake, 6 developments at Saline Lake, 6 at Nantachie Lake, 6 at Valentine Lake, 6 sites at Cane River Lake, 6 sites at Sibley Lake, 8 access sites at Black Lake, 8 sites at Clear Lake, 8 sites at Iatt Lake, and 1 site at each of the proposed low-water weirs on Bayou Pierre.

Water management structures on lakes and reservoirs:

Water level control devices should be provided at each of the Red River bendway cutoff lakes recommended for recreation-fish and wildlife development. Means of providing independent control of water levels in Black, Clear, Saline, and Larto Lakes and in Little River in Avoyelles Parish should be provided. Planning should also include a series of low weirs in Bayou Pierre in Caddo, DeSoto, and Natchitoches Parishes.

Land acquisition and greentree reservoir developments:

To help meet future hunting demands near Shreveport, it is proposed that approximately

13,000 acres of land along the Red River below Shreveport be acquired and managed for public hunting.

An excellent greentree waterfowl management site exists at Cunningham Brake near Red Dirt Game Management Area in Natchitoches Parish. This area is proposed for development, although construction of the Kisatchie Reservoir by the Corps of Engineers will inundate the site, destroying its potential for waterfowl development.

A 500-acre greentree area on Savage and Iatt Creeks is proposed for waterfowl development in Grant Parish.

To expand its facilities on the Saline Game Management Area in LaSalle Parish, the Louisiana Wild Life and Fisheries Commission has requested two greentree developments of about 500 acres each.

The acquisition of about 30,000 acres between Saline Lake and the Red River is proposed for development as a wildlife management and public hunting area.

To provide for a larger and more efficient waterfowl management unit, the Louisiana Wild Life and Fisheries Commission has requested a new earthen dam and water control gate be constructed above the present management dike within the Bayou Bodcau flood pool.

b. Suggested Ways of Implementing Fish and Wildlife Plan

Stream preservation:

Means of preserving streams or select reaches of streams will require that adjacent lands be purchased or leased. Acquisition will take the form of scenic easements or fee ownership. It is envisioned that fee ownership would be primarily at access points. The acquisition of necessary lands may involve joint Federal-State participation with respect to both administration and funding. Each stream must be evaluated separately to determine the most feasible solution to these requirements.

Costs: (include access developments)

Initial costs - $1,600,000
Annual O&M - $20,000

Benefits: (with access)

Annual man-days of fishing - 115,000
Annual value of above man-days - $172,500

Stream access development:

Bayou Dorcheat, Red River main stem, Catahoula Lake Diversion Channel, Flat River, and Red Chute Bayou will be affected by Corps of Engineers projects, and access should be provided at project cost.

The remaining access sites could be developed under existing Federal cost-sharing assistance programs.

Costs:

Initial costs - $10,000
Annual O&M - $400

Benefits:

Annual man-days of fishing - 8,500
Annual value of above man-days - $8,500

Lake and reservoir access developments:

Access to Teague Lake, Wallace Lake, Lock and Dam 6 on the Red River, Cane River Lake, Old River, Lock and Dam 1, and Twelvemile Bayou should be provided by the construction agency. The State would be responsible for development of access at other locations, with Federal cost-sharing assistance available.

Estimated costs and benefits of the State developments are as follows:

Costs:

Initial costs - $160,000
Annual O&M - $6,500

Benefits:

Annual man-days of fishing - 100,000
Annual value of above man-days - $100,000

Water management structures on lakes and reservoirs:

Water control structures should be provided at project cost in Red River bendway cutoff lakes. Structures in sites not affected by proposed projects could be provided by the State with possible Federal cost-sharing.

Estimated costs and benefits of proposed water management structures on lakes and reservoirs in Louisiana are as follows:

Costs:

Initial costs - $65,000
Annual O&M - $6,500

Benefits:

Annual man-days of fishing - 11,500
Annual value of above man-days - $11,500

The acquisition and development of a public hunting area below Shreveport could be provided through current State-Federal cost-sharing programs. Estimated costs and benefits of a 13,000-acre area are as follows:

Costs:

Initial costs - $2,600,000
Annual O&M - $13,000

Benefits:

Annual man-days of hunting - 12,000
Annual value of above man-days - $24,000

A 500-acre greentree development in Cunningham Brake near Red Dirt Game Management Area in Louisiana would involve the following estimated costs and benefits:

Costs:

Initial costs - $40,000
Annual O&M - $1,500

Benefits:

Annual man-days of hunting - 1,000
Annual value of above man-days - $4,000

Estimated costs and benefits of a 500-acre State-developed greentree area above Iatt Lake would be as follows:

Costs:

Initial costs - $55,000
Annual O&M - $1,500

Benefits:

Annual man-days of hunting - 1,000
Annual value of above man-days - $4,000

Estimated costs and benefits of two 500-acre greentree areas on Saline Game Management Areas are as follows:

Costs:

Initial costs - $80,000
Annual O&M - $3,000

Benefits:

Annual man-days of hunting - 2,000
Annual value of above man-days - $8,000

Acquisition and development of a 30,000-acre wildlife management area between Saline Lake and Red River would involve estimated costs and benefits as follows:

Costs:

Initial cost - $3,000,000
Annual O&M - $30,000

Benefits:

Annual man-days of hunting - 30,000
Annual value of above man-days - $60,000

Estimated costs and benefits of developing a 2,000-acre greentree area on Bayou Bodcau would be as follows:

Costs:

Initial cost - $60,000
Annual O&M - $6,000

Benefits:

Annual man-days of hunting - 4,000
Annual value of above man-days - $16,000

c. Effect of Proposed Federal Projects on Fish and Wildlife

Based on current project data, Corps of Engineers and Soil Conservation Service water resource projects in the Louisiana portion of the basin will result in benefits to sport and commercial fishing, and losses to wildlife habitat.

Fish and wildlife benefits and losses resulting from the Red River-Cypress Bayou Navigation project, the enlargement of Caddo Lake, the construction of Kisatchie Reservoir, and 4 authorized P. L. 566 projects and 19 watershed developments are summarized as follows:

Corps of Engineers (tables 33, 35, and 36)

Fishery benefits - 336,100 man-days of sport fishing; $26,800 commercial fishery value
Fishery losses - 2,500 man-days
Wildlife losses - 7,400 man-days
Wildlife benefits - 2,500 man-days

Soil Conservation Service (tables 34 and 37)

Fishery benefits - 78,600 man-days
Fishery losses - 1,700 man-days
Wildlife losses - 11,100 man-days
Wildlife benefits - 1,900 man-days

U. S. Forest Service

Fishery benefits - 8,000 man-days on 2,000 acres of recreation lakes

Preliminary studies indicate that wildlife losses resulting from Corps of Engineers projects could be mitigated through the development of wildlife

facilities on project-acquired lands, and on certain lands acquired specifically for mitigation purposes.

Wildlife losses assignable to the enlargement of Caddo Lake in Louisiana and to the Red River-Cypress Bayou navigation project could be compensated for by the acquisition of 530 acres of land adjacent to the existing Soda Lake Game Management area in Caddo Parish. This acreage would be developed primarily for waterfowl management and public hunting and turned over to the Louisiana Wild Life and Fisheries Commission. Estimated costs and benefits of this plan of mitigation are presented below. All costs are considered a project expense.

Land Acquisition - 530 acres		$ 79,500
Developments		
Diking - 530-acre reservoir		7,500
Water control structures		600
Pump		5,000
Total		$ 92,600
Annual Charge		$ 3,137
Operation and Maintenance		1,500
Benefits		
530 acres managed for general hunting	212 M.D. -	$ 424
530 acres general wildlife-oriented recreation	264 M.D. -	132
530 acres managed for waterfowl hunting	1,060 M.D. -	4,240
		$ 4,796

Wildlife losses resulting from the Corps of Engineers Kisatchie Reservoir project in Natchitoches Parish could be mitigated through the development of wildlife facilities on the reservoir site, and on certain lands adjacent to this site. The developments would include acquisition by the project of about 1,000 additional acres of land, diking for a 1,000-

acre waterfowl "greentree" reservoir, and intensive development of 3,000 acres of adjacent reservoir lands for maximum wildlife production and hunter use. Estimated costs and benefits of this plan are presented below.

Land Acquisition - 1,000 acres		$200,000
Developments		
Diking - 400-acre "greentree" reservoir		6,600
Water control structures (two)		1,200
Intensive upland game management		20,000
Total		$227,800
Annual Charge		$ 7,718
Operation and Maintenance		2,200
Benefits		
4,000 acres intensively managed for general hunting	4,000 M.D. -	$ 8,000
4,000 acres general wildlife-oriented recreation	2,000 M.D. -	1,000
400 acres managed for waterfowl	800 M.D. -	3,200
		$ 12,200

Wildlife losses associated with Soil Conservation Service projects in Louisiana will be compensated to some degree by normal watershed improvement practices. Design features, such as crest control gates for wildlife management, if included in project planning, would also contribute to the mitigation of project-occasioned losses. In view of the number of flood detention and single- and multiple-purpose structures included in early-action planning, project effects on fish and wildlife resources should be studied in depth on a watershed by watershed basis.

Losses to downstream fish and wildlife, beyond those tabulated above, will occur if adequate releases of water from reservoirs are not

planned. Regulated outflow should, in general, not be less than natural average minimum monthly streamflow for that month of the year. Such regulated flows should approximate the natural runoff cycle and tend to preserve downstream fish and wildlife resources.

3. Oklahoma

The State of Oklahoma, along with other States of the basin study area, will exhibit hunting needs at the available level of supply by 1980 (table 27). Except for streams, fishing needs are not anticipated until about the year 2000 (table 31). As in other States, localized needs for hunting and fishing will occur in certain parts of the basin.

a. State Plan for Meeting Future Fish and Wildlife Needs

Stream preservation proposals include:

Approximately 16 miles of Muddy Boggy Creek from its mouth on Red River upstream to near Unger, Oklahoma; 20 miles of the Kiamichi River from Red River upstream to near Sawyer, Oklahoma; and about 29 miles of the Kiamichi River from near Tuskahoma downstream to near Antlers, Oklahoma; about 20 miles of the Blue River upstream from the town of Milburn; approximately 47 miles of Little River from near the town of Hanobia downstream to the upper reach of the proposed Pine Creek Reservoir; about 71 miles of Little River downstream from the Pine Creek damsite; about 32 miles of Mountain Fork River above the Broken Bow Reservoir(4) and about 11 miles of this river below the dam to its junction with Little River; about 11 miles of the Mountain Fork River from the Broken Bow reregulating dam downstream to its juncture with Little River; 10 miles of Glover Creek from State Highway 3 downstream to its confluence with Little River; and 21 miles of Black Fork Creek upstream from its juncture with Little River.

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(4)This reach is located in the pool of the proposed Sherwood Reservoir, which is a feature of the early-action plan. The position of the Oklahoma Wildlife Conservation Commission with respect to the Sherwood Reservoir is enunciated in a resolution adopted by that body on May 6, 1968. A copy of the resolution is included in this appendix as attachment A.

Stream access developments:

It is estimated that 62 public access sites are needed along the 245 miles of streams designated for preservation in Oklahoma. To provide for public access to the Red River main stem, three sites have been included in this plan. The first site is immediately downstream from Denison Dam; the second site is near the town of Hendrix or Kemp City; and the last site is 4 miles west of Hendrix in Section 18. Access to this site would be across Section 19.

Water management structures:

Water control structures should be included at all of the larger Red River bendway cutoff lakes.

Land acquisition:

Construction agencies should consider the needs of wildlife resources in acquiring project lands. Frequently, a small acreage of valuable headwater bottom land hardwood habitat could be acquired for mitigation purposes. Such areas could easily be brought under management for wildlife production and public hunting. Special attention should be given to potential developments for waterfowl management and hunting.

Public access to wildlife management-public hunting areas:

All-weather roads to these facilities should be included in conjunction with wildlife developments.

Preservation of unique wildlife habitat:

Areas deserving preservation in their present condition include the Skyline Drive area of Southeastern Oklahoma, the Beavers Bend State Park in McCurtain County, the McCurtain County Game Refuge, and the Blue River bottom upstream from Milburn, Oklahoma.

Special planning items:

The Oklahoma Department of Wildlife Conservation requests that:

Consideration be given to establishing a trout fishery below Broken Bow Reservoir.

Water storage be considered for the Durant Fish Hatchery.

Several fish hatcheries be constructed below proposed reservoirs in Oklahoma.

Walkways be constructed adjacent to highway bridges to serve as fishing platforms and access sites.

Consideration be given to multilevel water outlets in reservoirs wherever warranted.

Water releases be made from Lake Texoma for downstream fish and wildlife.

The placement of berms and piers for fisherman use in tailraces of large reservoir projects when such facilities are found to be feasible or appropriate.

b. Suggested Ways of Implementing Fish and Wildlife Plan

Stream preservation:

Means of preserving streams or select reaches of streams will require that adjacent lands be purchased or leased. Acquisition will take the form of scenic easements or fee ownership. It is envisioned that fee ownership would be primarily required at access sites. The acquisition of necessary lands may involve joint Federal-State participation with respect to both administration and funding. Each stream must be evaluated separately to determine the most feasible solution to these requirements.

Estimated costs and benefits of stream preservation and related development of 62 access sites in Oklahoma are as follows:

Costs:

Initial costs - $159,000
Annual O&M - $25,000

Benefits:(5)

Annual man-days of fishing - 160,000
Annual value of above man-days - $320,000

Stream access developments:

Acquisition of land for access development on the Red River would require fee title ownership. Lands and related facilities could be developed under existing Federal cost-sharing assistance programs.

Costs:

Initial costs - $200,000
Annual costs - $10,000

Benefits:(6)

Annual man-days of fishing - 100,000
Annual value of above man-days - $100,000

Water management structures:

Water control structures in Red River bendway cutoff lakes should be provided by the project.

Special planning items:

The establishment of a trout hatchery below Broken Bow Reservoir, and other special items would be financed under existing Federal cost-sharing assistance programs. Detailed studies of each proposal will be required to determine costs and related benefits.

Wildlife habitat acquisition:

The State, in conjunction with current Federal cost-sharing provisions, could acquire and develop additional wildlife areas in Oklahoma. The absence of definite plans in this regard, however, precludes any estimates of costs and benefits.

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(5)Stream fishery benefits established at $2 per man-day for cool water fish habitat.
(6)Stream benefits established at $1 per man-day for warm water streams and rivers.

Public access to wildlife areas:

Access development should be a part of the acquisition of new wildlife areas. Access to existing areas should be provided by the State.

Preservation of unique wildlife habitat:

Where not affected by proposed construction projects, the State should be responsible for maintaining these areas. On project sites there would be a joint responsibility.

c. Effect of Proposed Federal Projects on Fish and Wildlife

Corps of Engineers and Soil Conservation Service water resource projects in the Oklahoma portion of the basin will increase sport and commercial fishing benefits at the cost of valuable stream fish habitat and wildlife habitat.

Fish and wildlife benefits and losses resulting from the construction of Durant, Albany, Parker, and McGee Creek Reservoirs, and the Tuskahoma and Sherwood Pump-Storage projects, the Red River bank stabilization project, 6 authorized 566 projects, and 12 early-action watershed plans are summarized as follows:

Corps of Engineers (tables 33, 35, and 36)

Fishery benefits - 305,000 man-days of sport fishing; $136,800 commercial fishery value
Fishery losses - 62,700 man-days
Wildlife benefits - 900 man-days
Wildlife losses - 22,600 man-days

Soil Conservation Service (tables 34 and 37)

Fishery benefits - 13,000 man-days
Fishery losses - 400 man-days
Wildlife benefits - 1,200 man-days
Wildlife losses - 6,400 man-days

U. S. Forest Service

Fishery benefits - 200 man-days on 45 acres of recreation lakes
Wildlife benefits - 1,000 man-days on 515 acres of greentree reservoirs
Wildlife benefits - 3,000 man-days on 13,765 acres of land to be acquired (based on gain of 223 man-days per 1,000 acres)

Preliminary studies indicate that wildlife losses associated with the proposed Sherwood Pump-Storage Reservoir and the Red River main stem bank stabilization project could be mitigated by the acquisition and development of a 5,000-acre tract of suitable wildlife habitat. This facility would be acquired by the project and turned over to the Oklahoma Department of Wildlife Conservation for wildlife production and public hunting. Estimated costs and benefits of this plan of mitigation are as follows:

Land Acquisition - 5,000 acres	$875,000
Developments	87,000
Total	$962,000
Annual Charge	$ 32,600
Operation and Maintenance	$ 5,000
Benefits	$52,800

Wildlife losses resulting from other Corps of Engineers water resource projects in Oklahoma could be mitigated if 33,000 acres of project-acquired reservoir lands are licensed to the Oklahoma Department of Wildlife Conservation for wildlife development and public hunting purposes. Access to these areas should be provided by the project and should consist of adequate all-weather roads. Bureau reports on these projects at the time of detailed study will contain specific recommendations regarding mitigation planning.

Wildlife losses associated with Soil Conservation Service projects in Oklahoma will be compensated to some degree by normal watershed improvement

practices. Design features, such as crest control gates for wildlife management, if included in project planning, would also contribute to the mitigation of project-occasioned losses. In view of the number of flood detention and single- and multiple-purpose structures included in early-action planning, project effects on fish and wildlife resources should be studied in depth on a watershed by watershed basis.

Losses to downstream fish and wildlife, beyond those tabulated above, will occur if adequate releases of water from reservoirs are not planned. Regulated outflow should, in general, not be less than natural average minimum monthly streamflow for that month of the year. Such regulated flows should approximate the natural runoff cycle and tend to preserve downstream fish and wildlife resources.

4. Texas

It is anticipated that there will be hunting needs at the available level of supply in the Texas portion of the basin by 1980 (table 28). Fishing needs for all types of water areas are also expected by 1980. Localized needs for fishing and hunting will likely exceed the State levels in certain areas.

a. State Plan for Meeting Future Fish and Wildlife Needs

Public fishery developments, public access developments, flow requirements, and needs for recreational areas will be determined during detailed study of specific projects. Special attention should be given to development of plans that would provide releases of at least 200 c.f.s. from Texarkana Reservoir for downstream fish and wildlife.

b. Effect of Proposed Federal Projects on Fish and Wildlife

Corps of Engineers and Soil Conservation Service water resource projects in the Texas portion of the basin will increase sport and commercial fishing benefits at the expense of wildlife habitat.

Fish and wildlife benefits and losses resulting from the construction of Titus County, Bonham and Liberty Hill Reservoirs, the Days Creek project, the enlargement of Caddo Lake, the Cypress Bayou navigation plan, and three authorized P. L. 566 projects and 14 early-action watershed programs are summarized as follows:

Corps of Engineers (tables 33, 35, and 36)

Fishery benefits - 486,800 man-days of sport fishing; $87,400 commercial fishery value
Fishery losses - 3,300 man-days
Wildlife benefits - 3,800 man-days
Wildlife losses - 9,600 man-days

Soil Conservation Service (tables 34 and 37)

Fishery benefits - 67,300 man-days of sport fishing
Fishery losses - 600 man-days
Wildlife benefits - 1,000 man-days
Wildlife losses - 3,700 man-days

U. S. Forest Service - no new construction planned

Preliminary studies indicate that wildlife losses associated with the proposed Bonham and Liberty Hill Reservoirs could be mitigated on project-acquired lands if these lands are licensed to the Texas Parks and Wildlife Department for wildlife production and public hunting. Bureau reports on these projects at the time of detailed study will contain specific recommendations regarding mitigation planning. Wildlife losses resulting from the construction of the Titus County Reservoir, the enlargement of Caddo Lake, and the Cypress Bayou Navigation project could be mitigated by the acquisition and development of a 2,000-acre tract of land in the Sulphur River bottoms below Texarkana Reservoir in Bowie and/or Cass Counties. This facility would be acquired by the project and turned over to the Texas Parks and Wildlife Department for wildlife production and public hunting. Estimated costs and benefits of this plan of mitigation are as follows:

Land Acquisition - 2,000 acres	$200,000
Development	30,700
Total	$230,700
Annual Charge	$ 7,800
Operation and Maintenance	$ 4,600
Annual Benefits	$ 12,500

Wildlife losses associated with Soil Conservation Service projects in Texas will be compensated to some extent by normal watershed improvement practices. Design features, such as crest control gates for wildlife management, if included in project planning, would also contribute to the mitigation of project-occasioned losses. In view of the number of flood detention and single- and multiple-purpose structures included in early-action planning, means of compensating for fish and wildlife losses should be determined as each respective watershed is studied in detail.

Losses to downstream fish and wildlife, beyond those tabulated below, will occur if adequate releases of water from reservoirs are not planned. Regulated outflow should, in general, not be less than natural average minimum monthly streamflow for that month of the year. Such regulated flows should approximate the natural runoff cycle and tend to preserve downstream fish and wildlife resources.

5. Special Basinwide Planning Features

Endangered species:

The preservation of rare and endangered wildlife species is a consideration that must be stressed in any basinwide fish and wildlife planning effort. Two species of endangered wildlife, the American alligator and the southern bald eagle, are occasionally found in the basin, while a third endangered species, the red wolf, is reported to exist in the more remote reaches of the study area.

Planning for these species centers on protective measures, which may include preservation of habitat,

elimination of harvest through public education, and other special management practices. The Land and Water Conservation Fund Act authorizes expenditures from this fund to acquire lands and waters for fish and wildlife threatened with extinction. It appears that a long-range habitat-preservation program is the most feasible approach to such planning in the Red River Basin.

Commercial fisheries:

By necessity, commercial fishery planning is treated on a basinwide concept. Indications are that planning considerations for this resource will be geared to fishmeal production. To adequately plan to meet future requirements for this type of fishery, a number of programs should be initiated. These would include a quantitative evaluation of the available resource base covering the entire Arkansas-White-Red Basin; the development of a high degree of institutional control over fishing effort by appropriate State agencies; the management of the fishery as an interlocking system of controlled harvesting units; additional research on the technical problems of volume harvesting methods under actual basin conditions; and an evaluation of the effects of intensive removal of commercial and forage species on game fish populations.

In addition, any realistic assessment of industrial fishery potentials must recognize sport fishing needs in developing a balanced program capable of maximizing benefits from the total fishery resource. There is considerable State interest in stocking carnivores such as striped bass, northern pike, muskellunge, and walleye in reservoirs. Sound management will call for allocation of the forage fish-industrial fish base to bring about the balanced maximization of both the sport and commercial fishery potentials.

Water quality control:

There exist in the basin numerous sources of pollution which are detrimental to fish and wildlife resources. With increased emphasis on industrial expansion, and corresponding population growth, the problem of water quality will become more acute in the foreseeable future. Established water quality standards should be implemented and enforced throughout the basin. Advanced waste treatment methods and augmentation of

flows from existing and proposed reservoirs would offer feasible solutions to this problem.

In conjunction with the comprehensive study of the Red River Basin below Denison Dam, the Federal Water Pollution Control Administration has identified sources of municipal and industrial pollution in the basin. Water quality storage for downstream pollution abatement has been included in several of the proposed water resource projects. Fish and wildlife benefits resulting from proposed water quality releases from these projects have been estimated, and are presented in table 38.

B. Long-Range Planning

Long-range planning for fish and wildlife in the Red River Basin should be considered as a continuing process, consisting of new project proposals and the implementation of current programs as the need arises and funds become available. As mentioned earlier in this report, planning beyond 10 to 15 years is not considered in this effort, but it is believed that certain long-range guidelines can be laid down at this time.

Elements of a long-range plan needed to protect and enhance fish and wildlife resources in the distant future will likely consist of additional stream preservation measures, additional public access facilities, the preservation of high-quality wildlife habitat for public use, provisions for reservoir management practices, and means of providing downstream flows in quality fishing streams.

VI. CONCLUSIONS

A. Arkansas

Fishing needs:

There is no anticipated need for fishing in Arkansas by 1980 (table 29). Localized needs, however, that may not be reflected in the State totals, can be met by the proposed stream preservation, access development, and reservoir projects proposed by the Corps of Engineers and Soil Conservation Service. Reservoir projects are evaluated in tables 33, 34, and 35.

Hunting needs:

The 1980 hunting needs in Arkansas (table 25) can be met by providing additional wildlife lands for public use and more intensive management of existing public lands. Proposed construction projects in Arkansas, without appropriate mitigation measures, will result in

significant losses of hunting opportunity (tables 36 and 37). Wildlife-oriented recreation benefits will be realized at the Dorcheat Reservoir site. Suggested means of offsetting losses are given in Section V of this appendix.

B. Louisiana

Fishing needs:

Louisiana will experience needs for all types of fishing water by 1980 (table 30). It is believed that stream and lake fishing needs can be met by preservation, additional access, and better management of these water areas. All types of impoundment-fishing needs can be met by the proposed water development projects, if adequate structures for fishery management and use are incorporated into construction plans. The evaluation of proposed reservoir projects by the Corps of Engineers and Soil Conservation Service is given in tables 33, 34, and 35.

Hunting needs:

The 1980 hunting needs in Louisiana (table 26) can be met by providing additional wildlife lands for public use and more intensive management of existing public lands. Proposed construction projects in Louisiana, without appropriate mitigation measures, will result in significant losses of hunting opportunity (tables 36 and 37). Wildlife-oriented recreation will provide additional project benefits through nature photography and bird watching, especially at the Kisatchie Reservoir site.

Suggested means of offsetting the losses are given in Section V of this appendix.

C. Oklahoma

Fishing needs:

There are no anticipated needs for fishing in Oklahoma by 1980 (table 31). Localized needs, however, that may not be reflected in the State totals, can be met by the proposed stream preservation and access development program, and reservoir projects proposed by the Corps of Engineers and the Soil Conservation Service. Reservoir projects are evaluated in tables 33, 34, and 35.

Hunting needs:

The 1980 hunting needs in Oklahoma (table 27) can be met by providing additional wildlife lands for public use and more intensive management of existing public lands. Proposed construction projects in Oklahoma, without appropriate mitigation measures, will

result in significant losses of hunting opportunity (tables 36 and 37).

Suggested means of offsetting losses attributable to the Sherwood Reservoir project and the Red River bank stabilization plan is presented in Section V of this appendix. Means to mitigate other project losses will be determined in Bureau reports on these individual projects. Wildlife-oriented recreation will provide additional project benefits through nature photography and bird watching. Our studies indicate that these benefits will amount to about 10,500 man-days annually at Corps of Engineers reservoir sites in Oklahoma.

D. Texas

Fishing needs:

Texas was the only State in the basin study area with estimated needs for fishing in 1960. These needs for all types of fishing will, of course, increase by 1980. It is doubtful that the increased needs for stream and lake fishing can be satisfied completely. Preservation and additional public access to these waters, however, could lessen the problem. All types of impoundment fishing can be met by the proposed water development projects, if adequate structures for fishery management and use are incorporated into construction plans. The evaluation of proposed reservoir projects by the Corps of Engineers and the Soil Conservation Service is given in tables 33, 34, and 35.

Hunting needs:

The 1980 hunting needs in Texas (table 28) can be met by providing additional wildlife lands for public use and more intensive management of existing public lands. Proposed construction projects in Texas, without appropriate mitigation measures, will result in significant losses of hunting opportunity (tables 36 and 37).

Suggested means of offsetting losses attributable to the Titus County Reservoir project, the Caddo Lake enlargement, and the Cypress Bayou navigation plan are presented in Section V of this appendix. Means of mitigating wildlife losses on other water resource projects in Texas will be given in Bureau reports on these projects. Wildlife-oriented recreation will provide additional project benefits through nature photography and bird watching. Our studies indicate that these benefits will amount to about 18,000 man-days annually at Corps reservoir sites in Texas.

E. Summary

In summary, the potential fish and wildlife resources of the Red River Basin study area are believed to be generally adequate to supply the demand for fishing and hunting until 1980. The realization of meeting the anticipated needs, however, will depend upon the concerted efforts of the respective State conservation agencies and the Federal construction agencies. Generally, the States will have the responsibility of preserving designated land and water areas, intensifying both fish and wildlife management programs, and providing additional public access to land and water habitat outside of project areas.

Collectively, the construction projects proposed by the Corps of Engineers and the Soil Conservation Service will result in net fishery benefits and net wildlife losses. The recommendations to facilitate fishing use and minimize wildlife losses should be considered for inclusion in construction plans, where feasible. This, however, will not offset the substantial wildlife losses caused by inundation of land area and clearing of bottom land forest for agricultural use. The mitigation of these project-induced losses by additional land acquisition or by wildlife developments on project lands, is considered an essential part of the fish and wildlife plan for the basin. Otherwise, wildlife resources of the future will be diminished rather than increased or maintained as a result of construction agency planning.

Table 1
Existing Wildlife Facilities
Red River Below Denison Dam
Arkansas Segment
1960

	Administering Agency	Location (County)	Total Acres in Basin	Activity or Purpose
FEDERAL FACILITIES				
Ouachita Natl. Forest	USFS	Polk, Howard	105,000	H, WP
Caney Creek Federal Game Refuge[1]	USFS-AG&FC	Polk	8,300	WP
Bayou Bodcau Res.	USCE	Lafayette	1,143	WP, H
STATE FACILITIES				
Sulphur River GMA	AG&FC	Miller	9,932	H, WP
Bois D'Arc GMA	AG&FC	Hempstead	6,300	H, WP
Howard County Game Refuge	AG&FC	Howard	33,000	WP
Lafayette Co. Game Refuge	AG&FC	Lafayette	18,360	WP
Hope Quail Area	AG&FC	Hempstead	2,116	H, WP

1. Caney Creek Federal Game Refuge located in Ouachita National Forest.

Legend:

USFS	U.S. Forest Service
USCE	U.S. Corps of Engineers
AG&FC	Arkansas Game and Fish Commission
H	Hunting
WP	Wildlife Production

Table 2
Existing Wildlife Facilities
Red River Below Denison Dam
Louisiana Segment
1960

	Administering Agency	Location (Parish)	Total Acres in Basin	Activity or Purpose
FEDERAL FACILITIES				
Kisatchie Natl. Forest	USFS	-	238,271	H, WP
Evangeline Div.	USFS	Rapides	11,630	H, WP
Kisatchie Div.	USFS	Natchitoches	94,137	H, WP
Catahoula Dist.	USFS	Grant	32,425	H, WP
Winn Dist.	USFS	Winn, Natchitoches	87,895	H, WP
Caney Dist.	USFS	Webster, Claiborne	12,184	H, WP
Bayou Bodcau Res.	USCE	Bossier, Webster	35,852	H, WP
Barksdale AFB	USAF	Bossier	17,642	H, WP
La. Ordnance Plant	USA	Bossier, Webster	13,500	WP
STATE FACILITIES				
Red Dirt GMA[1]	LW&FC	Natchitoches	38,000	H, WP
Catahoula GMA[1]	LW&FC	Grant, Winn	40,000	H, WP
Caney GMA	LW&FC	Webster, Claiborne	12,624	H, WP
Saline GMA	LW&FC	LaSalle, Catahoula	60,319	H, WP
Thistlethwaite GMA	LW&FC	St. Landry	11,100	H, WP
Alexander WMA[2]	LW&FC	Rapides	7,875	H, WP
Bayou Bodcau GMA[3]	LW&FC	Bossier, Webster	35,852	H, WP
Soda Lake WMA	LW&FC	Caddo	1,240	H, WP
Grassy Lake GMA	LW&FC	Avoyelles	26,000	H, WP

1. Superimposed on National forest lands.
2. Superimposed on State Forestry Commission lands.
3. Superimposed on USCE Bayou Bodcau Reservoir.

Legend:

USFS U.S. Forest Service
USCE U.S. Corps of Engineers
USA U.S. Army
USAF U.S. Air Force
LW&FC Louisiana Wild Life and Fisheries Commission
H Hunting
WP Wildlife Production

Table 3
Existing Wildlife Facilities
Red River Below Denison Dam
Oklahoma Segment
1960

	Administering Agency	Location (County)	Total Acres in Basin	Activity or Purpose
FEDERAL FACILITIES				
Ouachita Natl. Forest	USFS	LeFlore, McCurtain	135,000	H, WP
STATE FACILITIES				
McCurtain Co. Wilderness Area	ODWC	McCurtain	15,200	WP
Pushmataha Game Ref.	ODWC	Pushmataha	18,260	WP
Atoka Game Ref.	ODWC	Atoka	6,400	WP
Stringtown Deer Farm	ODWC	Atoka	2,260	H, WP
Boling Hollow Land	ODWC	Pittsburg	1,280	WP

Legend:

USFS U.S. Forest Service
ODWC Oklahoma Department of Wildlife Conservation
H Hunting
WP Wildlife Production

Table 4
Existing Wildlife Facilities
Red River Below Denison Dam
Texas Segment
1960

	Administering Agency	Location (County)	Total Acres in Basin	Activity or Purpose
FEDERAL FACILITIES				
Red River Arsenal	USA	Bowie	28,000	H, WP
Longhorn OrdnanceWks.	USA	Harrison	8,524	WP
Caddo Natl. Grass-lands	USFS	Fannin	17,729	H, WP
STATE FACILITIES				
Texarkana Res.[1]	TP&WD	Bowie, Cass	79,378	H, WP
Gambill Goose Ref.	TP&WD	Lamar	46	WP
Preserve No. 153	TP&WD,CP	Lamar	2,700	WP
Preserve No. 154	TP&WD,CP	Lamar	674	WP

1. Lands and waters of this Corps of Engineers project have been licensed to TP&WD. Included within this acreage is a 1,130-acre waterfowl development near Bassett, Texas.

Legend:

USA	U.S. Army
TP&WD	Texas Parks & Wildlife Department
WP	Wildlife Production
H	Hunting
CP	City of Paris
USFS	U.S. Forest Service

Table 5
Existing Fishery Facilities
Red River Below Denison Dam
Arkansas Segment
1960

	Administering Agency	Location (County)	Size (Acres)	Activity or Purpose
FEDERAL FACILITIES				
Shady Lake	USFS	Polk	30	F
STATE FACILITIES				
First Old River Lake	AG&FC	Miller	250	F
Lake Wilhelmina	AG&FC	Polk	300	F
Bois D'Arc Res.	AG&FC	Hempstead	705	F
MUNICIPAL FACILITIES				
Lake June	AG&FC	Lafayette	106	F
PRIVATE FACILITIES				
Lake Erling	IPC	Lafayette	7,300	F

Legend:

USFS	U.S. Forest Service
AG&FC	Arkansas Game and Fish Commission
IPC	International Paper Company
F	Fishing

Table 6
Existing Fishery Facilities
Red River Below Denison Dam
Louisiana Segment
1960

	Administering Agency	Location (Parish)	Size (Acres)	Activity or Purpose
FEDERAL FACILITIES				
Natchitoches Natl. Fish Hatchery	BSF&W	Natchitoches	97	FP
Caney Lakes	USFS	Webster	440	F
Valentine Lake	USFS	Rapides	80	F
Flagg Lake	USAF	Bossier	600	F
Moon Lake	USAF	Bossier	35	F
Clear Lake	USAF	Bossier	20	F
Harmon Lake	USAF	Bossier	55	F
Caddo Lake[1]	USCE	Caddo	13,900	F
Wallace Lake	USCE	Caddo	2,300	F
STATE FACILITIES				
Beechwood Fish Hatchery	LWFC	Rapides	250	FP
Lake Bistineau	LWFC, P	Bossier, Bienville & Webster	17,200	F
Smithport Lake	LWFC, P	DeSoto	2,950	F
Black Lake	LWFC, P	Caddo	3,960	F
Black-Saline-Clear Lakes	LWFC, P	Winn, Red R., Natchitoches	22,500	F
Cane River Lake	LWFC, P	Natchitoches	1,350	F
Kepler Creek Lake	LWFC, P	Bienville	1,725	F
Iatt Lake	LWFC, P	Grant	5,350	F
Ivan Lake	LWFC, P	Bossier	520	F
Ft. Buhlow Lake	P	Rapides	230	F
MUNICIPAL FACILITIES				
Cypress Bayou--Site 2	Town of Plain Dealing	Bossier	98	F
Cross Lake	Shreveport	Caddo	8,960	F

1. Lake partially in Texas; acreage given for Louisiana portion only.

Legend:

BSF&W	Bureau of Sport Fisheries and Wildlife
USCE	U.S. Corps of Engineers
USFS	U.S. Forest Service
LWFC	Louisiana Wild Life and Fisheries Commission
P	Parish (either Police Jury or local Game and Fish Comm.)
USAF	U.S. Air Force
FP	Fish Production
F	Fishing

Table 7
Existing Fishery Facilities
Red River Below Denison Dam
Oklahoma Segment
1960

	Administering Agency	Location (County)	Size (Acres)	Activity or Purpose
STATE FACILITIES				
Durant Fish Hatchery	ODWC	Bryan	651	FP
Schooler Lake	ODWC	Choctaw	35	F
Lake Raymond Gary	ODWC	Choctaw	390	F
Lake Ozzie Cobb	ODWC	Pushmataha	117	F
Lake Nanih Waiya	ODWC	Pushmataha	131	F
Clayton Lake	OIDPC	Pushmataha	75	F
MUNICIPAL LAKES				
Atoka Reservoir	Atoka	Atoka	5,500	F
Atoka City Lake	Atoka	Atoka	30	F
Hugo City Lake	Hugo	Choctaw	24	F
Boswell City Lake	Boswell	Choctaw	10	F
Wapanucha City Lake	Wapanucha	Johnston	10	F
Broken Bow City Res.	Broken Bow	McCurtain	40	F
Hocha Town Lake	Hochatown	McCurtain	20	F
Ada City Lake	Ada	Pontotoc	25	F

Legend:

ODWC Oklahoma Department of Wildlife Conservation
OIDPC Oklahoma Industrial Development and Parks Commission

Table 8

Existing Fishery Facilities
Red River Below Denison Dam
Texas Segment
1960

	Administering Agency	Location (County)	Size (Acres)	Activity or Purpose
FEDERAL FACILITIES				
Texarkana Res.	USCE	Bowie, Cass	29,200	F
Lake o' the Pines	USCE	Marion, Morris & Upshur	18,700	F
Caddo Lake	USCE	Marion, Harrison	13,100	F
Red R. Arsenal Lakes	(2) USA	Bowie	501	F
Davy Crockett Lake	USFS	Fannin	450	F
Coffee Mill Lake	USFS	Fannin	715	F
Lake Fannin	USFS	Fannin	47	F
STATE FACILITIES				
Bonham State Park Lake	TP&WD	Fannin	65	F
Daingerfield State Park Lake	TP&WD	Morris	60	F
MUNICIPAL FACILITIES				
Century Lake	Sulphur Sprgs	Hopkins	555	F
Coleman Lake	" "	Hopkins	33	F
White Oak Lake	" "	Hopkins	41	F
Lake Tankersly	Mt. Pleasant	Titus	135	F
Old City Lake	" "	Titus	30	F
Wolfe City Lake	Wolfe City	Hunt	35	F
Crook Lake	Paris	Lamar	1,200	F
PRIVATE FACILITIES				
Lone Star Lake	LSS	Morris	1,800	F
Club Lakes (25)	-	-	948	F

Legend:

USCE	U.S. Corps of Engineers
USA	U. S. Army
TP&WD	Texas Parks and Wildlife Department
LSS	Lone Star Steel Co.
F	Fishing
USFS	U.S. Forest Service

Table 9
Wildlife Habitat, Existing and Projected
Red River Below Denison Dam
Basinwide Summary

(Thousands of Acres of Habitat)

Type of Habitat	1960	1980	2000	2030	2080
1. Forest Type					
I. Bottom land					
a. Alluv. valley	1,103.7	931.6	781.1	636.3	618.6
b. Trib. bottoms	1,487.2	1,378.9	1,099.9	879.6	813.5
II. Upland	8,014.9	8.676.2	8,546.8	8,396.5	8,221.1
2. Cleared Land Type					
I. Alluvial Valley					
a. Pasture-range	564.6	594.3	600.1	60910	620.1
b. Cropland	708.6	608.6	588.6	562.3	528.0
II. Upland					
a. Pasture-range	2,710.0	2,575.2	2,664.6	2,805.5	3,004.1
b. Cropland	2,636.2	2,251.3	2,180.4	2,043.3	1,945.0
3. "Other" Land Type	338.3	277.9	395.5	471.1	479.1
4. Water Areas Suitable for Hunting	166.8	239.8	251.6	251.3	250.9
Total Acreage	17,730.3	17,433.8	17,108.6	16,684.9	16,480.4

Table 10
Evaluation of Fishery Habitat Types
Red River Below Denison Dam
(1960)

Type of Habitat	Average Man-Day Values per Acre			
	Arkansas	Louisiana	Oklahoma	Texas
Streams	7.8	7.5	8.6	14.2
Lakes	29.3	40.0	32.2	30.0
Large Impoundments	15.0	16.2	16.0	12.0
Small Impoundments	20.4	20.6	23.3	20.0
Private sector	30.4	20.0	40.0	20.0

1. Data obtained from respective State fishery research studies

Table 11
Evaluation of Wildlife Habitat Types
Average Man-Days per 1,000 Acres
Red River Below Denison Dam
1960

Type of Habitat	Available Level of Supply				Potential Level of Supply			
	Ark.	La.	Okla.	Tex.	Ark.	La.	Okla.	Tex.
A. Forest Land								
I. Bottom land								
a. Alluv.valley	78	214	62	123	228	320	257	224
b. Trib.bottoms	136	255	96	240	401	381	398	437
II. Upland	76	198	45	136	224	296	189	247
B. Cleared Land								
I. Alluv. Valley								
a. Cropland	76	121	50	116	223	181	209	211
b. Pasture-range	33	70	24	54	97	105	99	98
II. Upland								
a. Cropland	76	153	50	123	223	228	209	223
b. Pasture-range	33	29	22	55	99	44	90	100
C. "Other" Land	15	50	24	48	43	74	98	88
D. Permanent Water Suitable for Hunting Waterfowl	81	203	58	136	238	303	240	247

Table 12
Existing and Projected Level of Available Hunting
Red River Below Denison Dam
Arkansas
(Thousands)

	Acres of Habitat					Available Man-Days of Hunting				
	1960	1980	2000	2030	2080	1960	1980	2000	2030	2080
A. Forest Land										
I. Bottom-Land Hdwd.										
a. Alluv.valley	177.7	150.7	135.0	102.1	91.3	13.3	11.6	10.4	7.8	7.0
b. Trib. bottoms	362.3	359.9	357.4	353.7	347.6	49.5	49.3	48.9	48.4	47.6
c. Wetlands[1]	92.4	79.5	68.4	54.7	50.6	4.2	3.5	3.1	2.4	2.3
II. Upland Forest	1,449.8	1,547.6	1,513.5	1,463.9	1,439.0	110.5	116.1	113.5	109.8	107.9
B. Cleared Land										
I. Alluvial Valley										
a. Cropland	129.2	126.8	121.4	117.3	110.0	9.8	9.5	9.1	8.8	8.2
b. Pasture-range	58.0	66.0	66.7	67.6	69.9	1.9	2.2	2.2	2.2	2.3
II. Upland										
a. Cropland	254.4	197.2	185.0	166.0	144.0	19.3	14.9	14.0	12.6	10.9
b. Pasture-range	301.8	272.1	281.0	294.5	312.9	10.2	9.2	9.5	10.0	10.6
C. "Other" Land Class.[2]	6.7	8.8	30.8	64.1	64.1	.1	.1	.3	.6	.6
D. Permanent Water Suitable for Hunting Waterfowl	21.0	30.9	31.7	31.7	31.7	1.7	2.5	2.5	2.5	2.5
Total						221.0	218.9	213.5	205.1	199.9

1. This acreage is a part of bottom-land hardwoods and tributary bottoms.
2. Farmsteads, idle lands, etc.

Table 13
Existing and Projected Level of Available Hunting
Red River Below Denison Dam
Louisiana
(Thousands)

Habitat Type	Acres of Habitat					Available Man-Days of Hunting				
	1960	1980	2000	2030	2080	1960	1980	2000	2030	2080
A. Forest Land										
I. Bottom-Land Hdwd.										
a. Below Alex.	508.6	489.7	378.9	290.7	289.0	143.6	137.1	106.1	81.4	80.9
b. Above Alex.	309.5	196.5	175.8	156.9	155.3	30.1	19.1	17.0	15.2	15.1
c. Trib. bottoms	454.9	454.9	454.9	454.9	454.9	114.8	114.8	114.8	114.8	114.8
d. Wetlands[1]										
1.Below Alex.	133.0	106.4	85.1	61.3	54.5	2.8	2.2	1.8	1.3	1.1
2.Above Alex.	149.5	128.6	110.6	88.4	81.8	2.5	2.2	1.9	1.5	1.4
II. Upland Forest	2,126.6	2,522.5	2,560.3	2,623.3	2,706.6	417.0	489.4	496.7	508.9	525.1
B. Cleared Land										
I. Alluv. Valley										
a. Cropland	444.2	346.8	336.4	321.0	301.0	53.2	41.3	40.0	38.2	35.8
b. Pasture-range	425.8	443.2	447.6	454.3	462.4	29.5	31.0	31.3	31.8	32.4
II. Upland										
a. Cropland	114.7	113.2	112.4	111.3	110.0	17.3	16.8	16.7	16.6	16.4
b. Pasture-range	405.7	117.5	201.3	237.4	295.9	11.8	5.5	6.2	7.3	9.2
C. "Other" Land Class.[2]	145.1	106.9	121.6	144.0	144.0	7.1	5.2	5.9	7.0	7.0
D. Permanent Water Suitable for Hunting Waterfowl	90.9	109.2	113.2	112.9	112.5	18.2	2.2	2.3	2.2	2.2
Total						847.9	866.8	840.7	826.2	841.4

1. This acreage is a part of bottom-Land hardwoods and tributary bottoms.
2. Farmsteads, idle lands, etc.

Table 14
Existing and Projected Level of Available Hunting
Red River Below Denison Dam
Oklahoma
(Thousands)

Habitat Type	Acres of Habitat					Available Man-Days of Hunting				
	1960	1980	2000	2030	2080	1960	1980	2000	2030	2080
A. Forest Land										
I. Bottom-Land Hdwd.										
a. Alluv. valley	43.5	40.1	38.3	35.6	34.7	2.7	2.5	2.4	2.2	2.1
b. Trib. bottoms	249.3	233.7	218.8	197.9	166.4	23.9	22.5	21.0	19.0	16.0
c. Wetlands[1]	72.6	62.4	53.7	42.9	39.7	.5	.4	.4	.3	.2
II. Upland Forest	2,873.4	2,703.5	2,622.4	2,533.9	2,401.5	130.9	132.4	128.5	124.1	117.6
B. Cleared Land										
I. Alluvial Valley										
a. Cropland	65.6	77.8	75.4	71.2	67.0	3.3	3.9	3.7	3.5	3.3
b. Pasture-range	42.6	36.6	36.0	37.5	38.1	1.0	.8	.8	.8	.8
II. Upland										
a. Cropland	583.9	585.0	573.0	552.5	532.0	29.4	29.2	28.6	27.6	26.6
b. Pasture-range	932.8	839.5	848.7	865.4	882.2	20.1	20.1	20.4	20.7	21.2
C. "Other" Land Class.[2]	200.0	142.9	202.8	293.4	293.4	4.7	3.4	4.8	6.9	6.9
D. Permanent Water Suitable for Hunting Waterfowl	22.5	50.2	53.2	53.2	53.2	1.3	2.8	3.0	3.0	3.0
Total						217.8	219.0	213.6	208.1	197.7

1. This acreage is a part of bottom-land hardwoods and tributary bottoms.
2. Farmsteads, idle lands, etc.

Table 15
Existing and Projected Level of Available Hunting
Red River Below Denison Dam
Texas
(Thousands)

Habitat Type	Acres of Habitat					Available Man-Days of Hunting				
	1960	1980	2000	2030	2080	1960	1980	2000	2030	2080
A. Forest Land										
I. Bottom-Land Hdwd.										
a. Alluv. valley	64.3	54.6	53.1	51.0	48.3	7.9	6.7	6.5	6.3	5.9
b. Trib. bottoms	420.3	420.1	419.8	419.5	419.1	100.9	100.9	100.9	100.8	100.7
c. Wetlands[1]	120.0	103.2	88.7	70.9	65.6	4.4	37.8	32.4	25.9	24.0
II. Upland Forest	1,780.0	1,902.6	1,850.6	1,775.4	1,674.0	241.7	249.2	242.4	232.5	219.3
B. Cleared Land										
I. Alluv. Valley										
a. Cropland	69.2	57.2	55.4	52.8	50.0	8.0	6.5	6.3	6.0	5.7
b. Pasture-range	40.7	48.5	48.9	49.6	50.6	2.2	2.6	2.6	2.6	2.7
II. Upland										
a. Cropland	1,681.8	1,355.9	1,310.0	1,243.5	1,159.0	206.5	166.7	161.1	152.9	142.5
b. Pasture-range	1,198.7	1,286.1	1,333.6	1,408.2	1,513.1	65.6	70.7	73.3	77.4	83.2
C. "Other" Land Class.[2]	10.2	36.1	44.2	56.1	56.1	.5	1.7	2.1	2.7	2.7
D. Permanent Water Suitable for Hunting Waterfowl	32.4	49.5	53.5	53.5	53.5	4.4	6.7	7.2	7.2	7.2
Total						642.1	649.5	634.8	614.3	593.9

1. This acreage is a part of bottom-land hardwoods and tributary bottoms.
2. Farmsteads, idle lands, etc.

Table 16
Existing and Projected Level of Fishing Supply
Red River Below Denison Dam
Arkansas

Habitat Type	Acres of Habitat	Man-Days of Fishing (Thousands)
1960		
Streams	15,341	119.1
Lakes	7,183	210.8
Large impoundments	7,000	105.0
Small impoundments	764	15.6
Private sector	2,206	67.0
Total	32,494	517.5
1980		
Streams	14,265	101.2
Lakes	6,375	199.5
Large impoundments	40,665	625.0
Small impoundments	1,413	18.8
Private sector	3,721	118.6
Total	66,439	1,063.1
2000-2080		
Streams	14,265	101.2
Lakes	5,028	180.6
Large impoundments	40,665	625.0
Small impoundments	1,413	18.8
Private sector	5,806	159.2
Total	67,177	1,084.8

Table 17
Existing and Projected Level of Fishing Supply
Red River Below Denison Dam
Louisiana

Habitat Type	Acres of Habitat	Man-Days of Fishing (Thousands)
1960		
Streams	44,880	335.5
Lakes	22,163	887.2
Large impoundments	81,376	1,312.5
Small impoundments	1,644	33.9
Private sector	2,368	47.4
Total	152,422	2,616.7
1980		
Streams	44,880	335.5
Lakes	21,292	875.6
Large impoundments	82,876	1,319.1
Small impoundments	1,644	33.9
Private sector	6,122	122.4
Total	156,814	2,686.5
2000-2080		
Streams	44,880	335.5
Lakes	20,752	868.5
Large impoundments	82,876	1,319.1
Small impoundments	1,644	33.9
Private sector	10,603	212.1
Total	160,755	2,769.1

Table 18
Existing and Projected Level of Fishing Supply
Red River Below Denison Dam
Oklahoma

Habitat Type	Acres of Habitat	Man-Days of Fishing (Thousands)
1960		
Streams	21,468	185.0
Lakes	4,225	136.4
Large impoundments	5,500	88.0
Small impoundments	1,613	37.6
Private sector	4,718	188.7
Total	37,524	635.7
1980		
Streams	19,438	157.1
Lakes	4,112	133.8
Large impoundments	70,920	1,069.0
Small impoundments	1,613	40.0
Private sector	7,039	281.6
Total	103,122	1,681.5
2000-2080		
Streams	18,948	149.0
Lakes	3,925	129.5
Large impoundments	82,520	1,237.8
Small impoundments	1,613	40.0
Private sector	7,039	281.6
Total	114,045	1,837.9

Table 19
Existing and Projected Level of Fishing Supply
Red River Below Denison Dam
Texas

Habitat Type	Acres of Habitat	Man-Days of Fishing (Thousands)
1960		
Streams	4,925	69.9
Lakes	2,814	83.8
Large impoundments	66,380	872.2
Small impoundments	5,196	105.0
Private sector	3,183	63.6
Total	82,498	1,194.5
1980		
Streams	4,849	69.0
Lakes	2,626	82.3
Large impoundments	98,140	1,308.2
Small impoundments	5,196	105.0
Private sector	8,643	172.9
Total	119,454	1,738.3
2000-2080		
Streams	4,849	69.0
Lakes	2,444	80.9
Large impoundments	98,140	1,308.2
Small impoundments	5,196	105.0
Private sector	9,831	196.6
Total	120,460	1,759.7

Table 20
Hunting Demand, Present and Projected
Red River Below Denison Dam
Basinwide Summary

(Thousands of Man-Days)

Year	Basin Resident Demand				Total Resident Demand
	Arkansas	Louisiana	Oklahoma	Texas	
1960	221	848	218	642	1,929
1980	300	1,171	246	793	2,510
1990	336	1,262	260	767	2,625
2000	349	1,439	280	794	2,862
2010	375	1,367	290	803	2,835
2020	367	1,476	302	814	2,959
2030	397	1,581	282	822	3,082
2040	432	1,754	298	826	3,310
2050	473	1,951	317	831	3,572
2060	522	2,188	338	807	3,855
2070	580	2,455	325	784	4,144
2080	647	2,758	351	764	4,520

Table 21
Fishing Demand, Present and Projected
Red River Below Denison Dam
Basinwide Summary

(Thousands of Man-Days)

Year	Basin Resident Demand				Total Resident Demand
	Arkansas	Louisiana	Oklahoma	Texas	
1960	410	1,533	375	1,325	3,643
1980	830	2,939	616	2,263	6,648
1990	961	2,824	672	2,196	6,653
2000	1,000	3,471	731	2,267	7,469
2010	1,083	3,687	773	2,317	7,860
2020	1,064	4,054	822	2,377	8,317
2030	1,168	4,328	763	2,426	8,685
2040	1,292	4,843	822	2,468	9,425
2050	1,438	5,424	893	2,516	10,271
2060	1,608	6,146	974	2,496	11,196
2070	1,808	6,975	943	2,432	12,158
2080	2,040	7,886	1,039	2,402	13,367

Table 22
Commercial Fisheries, Harvest Records[1]
Red River Below Denison Dam
Basinwide Summary

Species[2]	Pounds					Value
	1958	1959	1960	1962	4-Year Average	4-Year Average
Bowfin	40,200	33,200	2,800	3,800	20,000	$ 987
Buffalofish	1,921,500	1,880,900	804,600	1,487,600	1,523,650	215,740
Carp	540,100	704,200	305,000	197,200	436,625	21,207
Catfish	800,500	613,900	283,200	684,000	595,400	136,825
Garfish	502,400	459,500	203,000	237,400	350,575	17,456
Paddlefish	15,700	19,300	10,700	64,100	27,450	1,447
Quillback	200	7,300	6,100	3,500	4,275	175
Sheephead	326,900	321,500	101,200	236,800	246,600	31,543
Sturgeon	900	500	400	-	450	64
Suckers	4,900	3,500	7,500	3,900	4,950	239
Total	4,153,300	4,043,800	1,724,500	2,918,300	3,209,975	$425,683

1. Data supplied by Bureau of Commercial Fisheries.

2. Miscellaneous and nonedible species (turtles, frogs, mussels) excluded.

Table 23
Commercial Fisheries
Existing Habitat and Harvest Capacity
Red River Below Denison Dam
Basinwide Summary

Habitat Type	Area (Acres)	Harvest Capacity (Pounds/Acre)	Total Capacity (Pounds)
Streams			
Main stem	50,583	50	2,529,150
Flood plain	13,044	50	652,200
Upland	5,694	50	284,700
Lakes			
Backwater	12,332	100	1,233,200
Overflow	19,054	35	666,890
Non-overflow	5,398	8	43,184
Impoundments			
Large (over 500 ac)	160,534	15	2,408,010[1]
Total	266,639		7,817,334

1. Large reservoirs have an additional potential capacity to produce 2,408,010 pounds of nonfood commercial fish (principally gizzard shad) based on a 15-pound-per-acre harvest capacity.

Table 24
Population Projections
Red River Below Denison Dam
Basinwide Summary

Year	Large Cities	Small Cities	Towns	Rural	Total
1960		247,154	349,885	589,274	1,186,313
1975		435,943	631,892	555,616	1,623,451
1980		480,420	711,721	546,928	1,739,069
1985		686,287	641,618	538,377	1,866,282
1990		838,769	637,485	529,951	2,006,205
1995		980,339	658,028	521,668	2,160,035
2000		1,137,073	679,981	513,512	2,330,566
2005	523,560	688,196	720,219	504,248	2,436,223
2010	571,307	721,121	761,097	495,154	2,548,679
2015	623,748	755,969	802,413	486,226	2,668,356
2020	681,816	846,025	790,387	477,462	2,795,690
2025	744,000	940,460	778,160	469,182	2,931,802
2030	795,173	1,042,006	779,108	458,767	3,075,054
2035	849,260	1,097,774	832,303	448,589	3,227,926
2040	906,643	1,157,331	888,416	438,646	3,391,036
2045	967,527	1,220,946	947,625	428,927	3,565,025
2050	1,033,000	1,288,946	1,009,575	419,729	3,751,250
2055	1,102,322	1,352,269	1,073,583	410,000	3,938,174
2060	1,176,336	1,420,822	1,141,530	400,500	4,139,188
2065	1,255,945	1,546,894	1,161,172	391,225	4,355,236
2070	1,341,085	1,630,860	1,233,126	382,169	4,587,240
2075	1,432,500	1,721,466	1,307,939	373,696	4,83[illegible],601
2080	1,530,196	1,817,536	1,388,526	365,417	5,101,675

Table 25
Hunting Needs by Types Associated with Supply Levels
Red River Basin Study Area
Arkansas

	Type of Hunting	M-D Supply (x 1,000) Available Level	Potential Level	M-D Demand Level	M-D Needs (x 1,000) Available Level	Potential Level
1960						
	Big game	17.7	51.9	17.7 (8%)	-	-
	Small Game	194.5	571.2	194.5 (88%)	-	-
	Waterfowl	8.8	25.9	8.8 (4%)	-	-
	Total	221.0	649.0	221.0	-	-
1980						
	Big game	17.5	50.3	24.0	6.5	-
	Small game	192.7	553.2	264.0	71.3	-
	Waterfowl	8.8	25.1	12.0	3.2	-
	Total	219.0	628.6	300.0	81.0	-
2000						
	Big game	17.0	47.8	27.9	10.0	-
	Small game	187.4	525.8	307.1	119.7	-
	Waterfowl	8.1	23.9	13.9	5.8	-
	Total	213.0	597.5	349.0	136.0	-
2030						
	Big game	16.4	44.4	31.7	15.3	-
	Small game	180.4	489.0	349.4	169.0	-
	Waterfowl	8.2	22.2	15.9	7.7	-
	Total	205.0	555.6	397.0	192.0	-
2080						
	Big game	16.0	42.9	51.7	35.7	8.8
	Small game	176.0	471.6	569.4	393.4	97.8
	Waterfowl	8.0	21.4	25.9	17.9	4.5
	Total	200.0	535.9	647.0	447.0	111.1

Table 26
Hunting Needs by Types Associated with Supply Levels
Red River Basin Study Area
Louisiana

	M-D Supply (x 1,000)			M-D Needs (x 1,000)	
Type of Hunting	Available Level	Potential Level	M-D Demand Level	Available Level	Potential Level
1960					
Big game	67.8	101.7	67.8(8%)	-	-
Small game	746.2	1,119.4	746.2(88%)	-	-
Waterfowl	33.9	50.9	33.9(4%)	-	-
Total	848.0	1,272.0	848.0	-	-
1980					
Big game	69.3	101.2	93.7	24.4	-
Small game	762.9	1,112.6	1,030.5	267.6	-
Waterfowl	34.8	50.6	46.8	12.0	-
Total	867.0	1,264.4	1,171.0	304.0	-
2000					
Big game	67.2	95.8	115.1	47.9	19.3
Small game	740.0	1,053.7	1,266.3	526.3	212.6
Waterfowl	33.8	47.9	57.5	23.7	9.6
Total	841.0	1,197.4	1,439.0	597.9	241.5
2030					
Big game	66.0	91.3	126.5	64.1	35.2
Small game	726.8	1,004.2	1,391.3	704.7	387.1
Waterfowl	33.2	45.6	63.2	32.0	17.6
Total	826.0	1,141.1	1,581.0	800.8	439.9
2080					
Big game	67.2	92.2	220.6	153.4	128.4
Small game	740.0	1,014.5	2,427.0	1,687.0	1,412.5
Waterfowl	33.8	46.1	110.3	76.5	64.2
Total	841.0	1,152.8	2,758.0	1,916.9	1,605.1

Table 27
Hunting Needs by Types Associated with Supply Levels
Red River Basin Study Area
Oklahoma

	Type of Hunting	M-D Supply (x 1,000) Available Level	Potential Level	M-D Demand Level	M-D Needs (x 1,000) Available Level	Potential Level
1960						
	Big game	17.4	72.5	17.4(8%)	-	-
	Small game	191.8	797.4	191.8(88%)	-	-
	Waterfowl	8.7	36.2	8.7(4%)	-	-
	Total	218.0	906.1	218.0	-	-
1980						
	Big game	17.4	72.3	19.7	2.3	-
	Small game	191.8	795.4	216.5	24.7	-
	Waterfowl	8.8	36.1	9.8	1.0	-
	Total	218.0	903.8	246.0	28.0	-
2000						
	Big game	17.1	70.4	22.4	5.3	-
	Small game	188.3	775.0	246.4	58.1	-
	Waterfowl	8.6	35.2	11.2	2.6	-
	Total	214.0	880.6	280.0	66.0	-
2030						
	Big game	16.6	67.6	22.5	5.9	-
	Small game	183.0	743.9	248.2	65.2	-
	Waterfowl	8.4	33.8	11.3	3.1	-
	Total	208.0	845.3	282.0	74.2	-
2080						
	Big game	15.8	65.0	28.1	12.3	-
	Small game	174.2	715.0	308.9	134.7	-
	Waterfowl	8.0	32.5	14.0	6.0	-
	Total	198.0	812.5	351.0	153.0	-

Table 28

Hunting Needs by Types Associated with Supply Levels
Red River Basin Study Area
Texas

	Type of Hunting	M-D Supply (x 1,000) Available Level	M-D Supply (x 1,000) Potential Level	M-D Supply (x 1,000) M-D Demand Level	M-D Needs (x 1,000) Available Level	M-D Needs (x 1,000) Potential Level
1960						
	Big game	51.4	92.1	51.4(8%)	-	-
	Small game	564.9	1,013.5	564.9(88%)	-	-
	Waterfowl	25.7	46.1	25.7(4%)	-	-
	Total	642.0	1,151.7	642.0	-	-
1980						
	Big game	52.0	87.6	63.4	11.4	-
	Small game	572.0	964.0	697.8	125.8	-
	Waterfowl	26.0	43.8	31.7	5.7	-
	Total	650.0	1,095.5	793.0	142.9	-
2000						
	Big game	50.8	84.7	63.6	12.7	-
	Small game	558.8	928.8	698.7	139.9	-
	Waterfowl	25.4	42.2	31.7	6.3	-
	Total	635.0	1,055.7	794.0	158.9	-
2030						
	Big game	49.1	80.2	65.7	16.6	-
	Small game	540.3	882.0	723.4	183.1	-
	Waterfowl	24.6	40.1	32.9	8.3	-
	Total	614.0	1,002.3	822.0	208.0	-
2080						
	Big game	47.5	76.8	61.1	13.6	-
	Small game	522.7	844.5	672.3	149.6	-
	Waterfowl	23.8	38.4	30.6	6.8	-
	Total	594.0	959.7	764.0	170.0	-

Table 29
Existing Sport Fishery Resources and
Future Capabilities and Needs (in Thousands)
Red River Below Denison Dam
Arkansas

	Area of Habitat	Habitat Capacity	Resident Fishing Demand	% of Capacity	Needs (M-D)
1960					
Streams	15,341	119.1	94.2	79	-
Lakes	7,183	210.8	167.9	80	-
Large impoundments	7,000	105.0	86.6	82	-
Small impoundments	764	15.6	7.6	49	-
Private sector[1]	2,206	67.0	53.2	79	-
Total	32,494	517.5	409.5	79	-
1980					
Streams	14,265	101.2	101.2	100	-
Lakes	6,375	199.5	127.5	64	-
Large impoundments	40,665	625.0	488.0	78	-
Small impoundments	1,413	18.8	9.6	50	-
Private sector[1]	3,721	118.6	103.0	87	-
Total	66,439	1,063.1	829.3	78	-
2000					
Streams	14,265	101.2	120.0	118	18.8
Lakes	5,028	180.6	150.1	83	-
Large impoundments	40,665	625.0	590.2	94	-
Small impoundments	1,413	18.8	10.0	53	-
Private sector[1]	5,806	159.2	130.1	82	-
Total	67,177	1,084.8	1,000.4	92	18.8
2030					
Streams	14,265	101.2	140.1	138	38.9
Lakes	5,028	180.6	175.1	97	-
Large impoundments	40,665	625.0	688.9	110	63.9
Small impoundments	1,413	18.8	11.7	62	-
Private sector[1]	5,806	159.2	151.8	95	-
Total	67,177	1,084.8	1,167.6	107	102.8
2080					
Streams	14,265	101.2	244.8	242	143.6
Lakes	5,028	180.6	306.1	169	125.5
Large impoundments	40,665	625.0	1,203.9	192	578.9
Small impoundments	1,413	18.8	20.4	107	1.4
Private sector[1]	5,806	159.2	265.3	166	106.1
Total	67,177	1,084.8	2,040.5	188	955.5

1. Farm ponds, SCS flood-retarding structures, generally found on private lands and not open to public use.

Table 30
Existing Sport Fishery Resources and
Future Capabilities and Needs (in Thousands)
Red River Below Denison Dam
Louisiana

	Area of Habitat	Habitat Capacity	Resident Fishing Demand	% of Capacity	Needs (M-D)
1960					
Streams	44,880	335.5	199.2	59	-
Lakes	22,163	887.2	521.0	59	-
Large impoundments	81,367	1,312.5	758.2	57	-
Small impoundments	1,644	33.9	23.4	69	-
Private sector[1]	2,368	47.4	30.6	64	-
Total	152,422	2,616.5	1,532.4	58	0
1980					
Streams	44,880	335.5	352.7	105	17.2
Lakes	21,292	875.6	881.8	101	6.2
Large impoundments	82,876	1,319.1	1,499.0	114	179.9
Small impoundments	1,644	33.9	49.3	145	15.4
Private sector[1]	6,122	122.4	156.4	128	34.0
Total	156,814	2,686.5	2,939.2	109	252.7
2000					
Streams	44,880	335.5	416.4	124	80.9
Lakes	40,752	868.5	1,041.1	119	172.6
Large impoundments	82,876	1,319.1	1,769.9	134	450.8
Small impoundments	1,644	33.9	69.4	204	35.5
Private sector[1]	10,603	212.1	173.5	82	-
Total	160,755	2,769.1	3,470.3	125	739.8
2030					
Streams	44,880	335.5	519.4	155	183.9
Lakes	20,752	868.5	1,298.5	150	436.6
Large impoundments	82,876	1,319.1	2,207.4	167	888.3
Small impoundments	1,644	33.9	86.5	255	52.6
Private sector[1]	10,603	212.1	216.4	102	4.3
Total	160,755	2,769.1	4,328.2	156	1,565.7
2080					
Streams	44,880	335.5	946.4	282	610.9
Lakes	20,752	868.5	2,365.9	276	1,508.0
Large impoundments	82,876	1,319.1	4,022.1	306	2,703.0
Small impoundments	1,644	33.9	157.7	465	123.8
Private sector[1]	10,603	212.1	394.3	186	182.2
Total	160,755	2,769.1	5,886.4	286	5,127.9

1. Farm ponds, SCS flood-retarding structures, generally found on private lands and not open to public use.

Table 31
Existing Sport Fishery Resources and
Future Capabilities and Needs (in Thousands)
Red River Below Denison Dam
Oklahoma

	Area of Habitat	Habitat Capacity	Resident Fishing Demand	% of Capacity	Needs (M-D)
1960					
Streams	21,468	185.0	108.8	59	-
Lakes	4,225	136.4	78.8	58	-
Large impoundments	5,500	88.0	52.0	59	-
Small impoundments	1,613	37.6	23.0	61	-
Private sector[1]	4,718	188.7	112.5	60	-
Total	37,524	635.7	375.1	59	-
1980					
Streams	19,438	157.1	157.1	100	-
Lakes	4,112	133.8	21.0	16	-
Large impoundments	70,920	1,069.0	381.7	36	-
Small impoundments	1,613	40.0	12.3	31	-
Private sector[1]	7,039	281.6	43.5	15	-
Total	103,122	1,681.5	615.6	37	-
2000					
Streams	18,948	149.0	190.0	127	32.9
Lakes	3,925	129.5	21.9	17	-
Large impoundments	82,520	1,237.8	453.2	37	-
Small impoundments	1,613	40.0	14.6	36	-
Private sector[1]	7,039	281.6	51.2	18	-
Total	114,045	1,837.9	731.0	40	32.9
2030					
Streams	18,948	149.0	198.5	133	49.5
Lakes	3,925	129.5	22.9	17	-
Large impoundments	82,520	1,237.8	473.3	38	-
Small impoundments	1,613	40.0	15.3	38	-
Private sector[1]	7,039	281.6	53.4	19	-
Total	114,045	1,837.9	763.4	41	49.5
2080					
Streams	18,948	149.0	270.0	172	181.2
Lakes	3,925	129.5	31.1	23	-
Large impoundments	82,520	1,237.8	643.9	52	-
Small impoundments	1,613	40.0	20.8	52	-
Private sector[1]	7,039	281.6	72.7	26	-
Total	114,045	1,837.9	1,038.5	56	181.2

1. Farm ponds, SCS flood-retarding structures, generally found on private lands and not open to public use.

Table 32
Existing Sport Fishery Resources and
Future Capabilities and Needs (in Thousands)
Red River Below Denison Dam
Texas

	Area of Habitat	Habitat Capacity	Resident Fishing Demand	% of Capacity	Needs (M-D)
1960					
Streams	4,925	69.9	79.5	114	9.6
Lakes	2,814	83.8	92.7	111	8.9
Large impoundments	66,380	872.2	946.1	108	73.9
Small impoundments	5,196	105.0	140.6	134	35.6
Private sector[1]	3,183	63.6	66.2	104	2.6
Total	82,498	1,194.5	1,325.1	111	130.6
1980					
Streams	4,849	69.0	90.5	131	21.5
Lakes	2,626	82.3	113.2	137	30.9
Large impoundments	98.140	1,308.2	1,672.6	128	364.4
Small impoundments	5,196	105.0	183.1	174	78.1
Private sector[1]	8,643	172.9	203.8	118	30.9
Total	119,454	1,738.3	2,263.2	130	524.8
2000					
Streams	4,849	69.0	90.7	131	21.7
Lakes	2,444	80.9	113.3	140	32.4
Large impoundments	98,140	1,308.2	1,677.3	128	369.1
Small impoundments	5,196	105.0	181.3	172	76.3
Private sector[1]	9,831	196.6	204.0	104	7.4
Total	120,460	1,759.7	2,266.6	129	506.9
2030					
Streams	4,849	69.0	97.0	140	28.0
Lakes	2,444	80.9	121.3	150	40.4
Large impoundments	98,140	1,308.2	1,795.4	137	487.2
Small impoundments	5,196	105.0	194.1	185	89.1
Private sector[1]	9,831	196.6	218.3	111	21.7
Total	120,460	1,759.7	2,426.1	138	666.4
2080					
Streams	4,849	69.0	96.1	139	27.1
Lakes	2,444	80.9	120.1	148	39.2
Large impoundments	98,140	1,308.2	1,777.2	136	469.0
Small impoundments	5,196	105.0	192.1	183	87.1
Private sector[1]	9,831	196.6	216.1	110	19.5
Total	120,460	1,759.7	2,401.6	136	641.9

1. Farm ponds, SCS flood-retarding structures, generally found on private lands and not open to public use.

Table 33
Fishery Benefits and Losses Attributed to
Proposed Corps Projects
Red River Below Denison Dam
Early Action Projects

Proposed Project	Acres			Man-Days[1]	
	Conservation Pool	Stream Inundation	Stream Channelization	Benefits	Losses
Arkansas					
Dorcheat Res.	17,300	249	-	69,000	1,300
Posten Bayou	-	-	-	-	-
McKinney Bayou	-	-	110	-	-
Red River Main Stem	-	-	-	1,000	-
Louisiana					
Kisatchie Res.	9,180	167	-	147,000	2,500
Caddo Lake (Enlargement)	800	-	-	12,800	-
Red River Main Stem and Tributary Navigation	-	-	-	176,300	-
Oklahoma					
Durant Res.	8,980	25 mi.	-	19,000	5,000
Albany Res.	4,960	12 mi.	-	6,000	500
Parker Res.	6,110	32 mi.	-	13,000	3,000
Sherwood Res.	30,700	25 mi.	-	260,000	30,500
Tuskahoma Storage	590	3 mi.	-	-	-
McGee Creek Res.	3,500	16 mi.	-	7,000	1,700
Red River Main Stem	-	-	-	-	22,000
Texas					
Caddo Lake (Enlargement)	7,800	30	-	93,600	600
Titus Co. Res.	12,200	74	-	220,000	1,500
Bonham Res.	5,280	7 mi.	-	34,500	210
Liberty Hill Res.	7,070	25 mi.	-	50,000	1,000
Days Creek	-	-	20	-	40
Cypress Bayou Navigation	-	-	-	88,700	-

1. Benefits are reservoir fishing valued at $1 per man-day. Losses are stream fishing.

Table 34

Fishery Benefits and Losses Attributed to Proposed SCS Projects
Red River Below Denison Dam
Early Action Projects

Proposed Project	Acres	Miles		Man-Days[1]	
	Conservation Pool	Stream Inundation	Stream Channelization[2]	Benefits	Losses
Arkansas					
Single-purpose rec. res.	550	-	-	1,600	-
Multiple-purpose rec. res.	597	-	-	1,800	-
Other reservoirs[3]	3,275	-	-	16,400	-
All watersheds (7)	-	-	260	-	500
Louisiana					
Single-purpose rec. res.	2,040	-	-	6,100	-
Multiple-purpose rec.res.	7,223	-	-	21,700	-
Other reservoirs	10,167	-	-	50,800	-
All watersheds (23)	-	-	894	-	1,700
Oklahoma					
Single-purpose rec. res.	480	-	-	1,000	-
Multiple-purpose rec. res.	780	-	-	1,600	-
Other reservoirs	10,370	-	-	10,400	-
All watersheds (18)	-	-	167	-	400
Texas					
Single-purpose rec. res.	-	-	-	-	-
Multiple-purpose rec. res.	1,042	-	-	20,800	-
Other reservoirs[3]	9,303	-	-	46,500	-
All watersheds (15)	-	-	159	-	600

1. Benefits are reservoir fishing valued at $1 per man-day. Losses are stream fishing.

2. 25% of the stream miles to be channeled are considered fishable.

3. Includes reservoirs for flood prevention, irrigation, water quality control, and water supply.

Table 35
Commercial Food and Industrial Fishery Resources
Attributed to Proposed Corps Projects
Red River Below Denison Dam
Early Action Projects

Proposed Reservoir	Conservation Pool Acreage	Food Fish Harvest Capacity	Value[1]	Industrial Fish Harv. Capacity	Value[1]
Arkansas					
Dorcheat	17,300	259,500	$39,000	259,500	$7,800
Louisiana					
Caddo Lake (Enlargement)	800	12,000	1,800	12,000	360
Kisatchie	9,180	137,700	20,600	137,700	4,100
Oklahoma[4]					
Durant[2]	8,980	126,000	19,000	-	-
Albany[2]	4,960	62,000	9,300	-	-
Parker[2]	6,110	86,000	13,000	-	-
Sherwood[2]	30,700	125,000	19,000	-	-
Tuskahoma Forebay	590	-	-	-	-
McGee Creek[3]	3,500	52,500	7,900	70,000	2,100
Texas					
Caddo Lake (Enlargement)	7,800	117,000	17,500	117,000	3,500
Titus County	12,200	183,000	27,500	183,000	5,500
Bonham	5,280	79,200	11,900	79,200	2,400
Liberty Hill	7,070	106,000	15,900	106,000	3,200

1. Food Fish values set at $0.15 per pound net, and $0.03 per pound net for industrial fish.

2. Food and industrial fish poundages and related values combined for these reservoirs in Oklahoma.

3. McGee Creek Reservoir commercial fishery values based on Parker Reservoir data.

4. It is estimated that bank stabilization features of the Red River main stem in Oklahoma will result in a 14,000-pound annual commercial fish loss.

Table 36
Wildlife Benefits and Losses Attributed
to Proposed Corps Projects
Red River Below Denison Dam
Early Action Projects

Proposed Project	Acres		Man-Days[1]		
	Lands Inundated	Lands Cleared	W/L-Oriented Recreation Benefits	Hunting Benefits	Hunting Losses
Arkansas					
Dorcheat Reservoir	17,300	-	8,600	1,700	6,900
Posten Bayou	-	2,600	-	-	600
McKinney Bayou	-	2,900	-	-	700
Red River Main Stem	-	-	-	-	1,400
Louisiana					
Kisatchie Reservoir	9,180	7,900	4,600	2,400	5,000
Caddo Lake (Enlargement)	800	-	400	100	300
Red River Main Stem and Tributary Navigation	-	-	-	-	2,100
Oklahoma					
Durant Reservoir	8,980	300	5,000	400	1,000
Albany Reservoir	4,960	244	300	-	2,300
Parker Reservoir	6,110	458	3,200	200	2,800
Sherwood Reservoir	30,700	-	500	200	4,700
Tuskahoma Storage	590	-	-	-	300
McGee Creek Reservoir	3,500	-	1,700	100	1,500
Red River Main Stem	-	-	-	-	10,000
Texas					
Caddo Lake (Enlargement)	7,800	-	3,900	780	2,700
Titus Co. Res.	12,200	-	6,100	2,200	2,400
Bonham Res.	5,280	349	7,400	500	1,700
Liberty Hill Res.	7,070	71	2,500	300	2,000
Days Creek	-	-	-	-	-
Cypress Bayou Navigation	-	-	-	-	800

1. Benefits are wildlife-oriented recreation and upland game, big game, and waterfowl hunting, valued at $0.50 to $6 per man-day. Losses are upland game, big game, and waterfowl hunting.

Table 37
Wildlife Benefits and Losses Attributed
to Proposed SCS Projects
Red River Below Denison Dam
1980

Proposed Project	Acres		Man-Days[1]	
	Lands Inundated	Land Cleared	Benefits	Losses
Arkansas				
Single-purpose rec. res.	550	-	100	-
Multiple-purpose rec. res.	597	-	100	-
Other reservoirs[2]	3,275	-	300	-
All watersheds (7)	-	9,800	-	3,700
Louisiana				
Single-purpose rec. res.	2,040	-	200	-
Multiple-purpose rec. res.	7,223	-	700	-
Other reservoirs[2]	10,167	-	1,000	-
All watersheds (23)	-	20,500	-	11,100
Oklahoma				
Single-purpose rec. res.	480	-	100	-
Multiple-purpose res.	780	-	100	-
Other reservoirs[2]	10,370	-	1,000	-
All watersheds (18)	-	14,700	-	6,400
Texas				
Single-purpose rec. res.	-	-	-	-
Multiple-purpose rec. res.	992	-	100	-
Other reservoirs[2]	9,303	-	900	-
All watersheds (15)	-	4,000	-	3,700

1. Benefits are primarily waterfowl hunting, valued at $4 per man-day. Losses are primarily forest game-deer, turkeys, and squirrels.

2. Includes reservoirs for flood prevention, irrigation, water quality control, and water supply.

Table 38
Fish and Wildlife Benefits Assignable
to Storage for Water Quality Control

Reservoir Project	Stream	Fish and Wildlife Benefits in Dollars
Dorcheat	Dorcheat Bayou, Arkansas and Louisiana	$13,000
	Bayou Bodcau, Louisiana	4,000
	Total	$17,000
SCS Watershed 3ml-7	Big Creek, Arkansas	$ 500
	Dorcheat Bayou Arkansas and Louisiana	13,000
	Total	$13,500
SCS Watershed 3-23	Mineral Bayou, Oklahoma	$ 800

1. This is a joint Ce-SCS plan, with initial needs in Dorcheat Bayou to be supplied by storage in the SCS project.

Table 39
Congressional Acts Providing Assistance in
Fish and Wildlife Planning

Migratory Bird Conservation Act. Act of February 18, 1929, (45 Stat. 1222 as amended 16 U.S.C. 715-715s). Authorizes the acquisition of lands for migratory bird refuges.

Fish and Wildlife Coordination Act. Act of March 10, 1934, (48 Stat. 401 as amended 16 U.S.C. 661-666c). Authorizes assistance to Federal, State, and other agencies in the development, protection, rearing and stocking of fish and wildlife and controlling losses thereof; authorizes surveys of fish and wildlife of all Federal lands and on the effects of pollution; authorizes surveys and reports by the Fish and Wildlife Service which recommend measures needed to prevent losses of, and to enhance, fish and wildlife at water-use projects constructed or licensed by the Federal Government; authorizes land acquisition for fish and wildlife conservation purposes; and authorizes Federal construction agencies to incorporate conservation measures into Federal water-use projects and to make available project lands for use and administration by Bureau of Sport Fisheries and Wildlife or State wildlife agencies.

Federal Aid in Wildlife Restoration Act. Act of September 2, 1937, (50 Stat. 917 as amended 16 U.S.C. 669-669j). Provides Federal grants to States in wildlife restoration projects. Funds from an excise tax on sporting arms and ammunition are provided to States on a matching basis of $3 Federal to $1 State for research, land acquisition, development, maintenance, and management projects.

Federal Water Pollution Control Act. Act of June 30, 1948, (62 Stat. 1115 as amended 33 U.S.C. 446-446k). Provides for water pollution control activities including interstate cooperation, research, investigations, and Federal aid to the States; establishes a Federal Water Pollution Control Administration with authority to require the abatement of pollution in interstate streams: and requires establishment of water quality criteria.

Federal Aid in Sport Fish Restoration Act. Act of August 9, 1950, (64 Stat. 430 as amended 16 U.S.C. 777-777k). Provides Federal grants to States for sport fish restoration projects. Funds from excise tax on certain items of sport fishing tackle are provided to States on a matching basis of $3 Federal to $1 State for research, land acquisition, development, maintenance, and management projects.

Watershed Protection and Flood Prevention Act. Act of August 4, 1954, (68 Stat. 666 as amended 16 U.S.C. 1001-1009). Authorizes certain fish and wildlife improvement activities at small watershed projects, including: (1) surveys, investigations, and reports with recommendations concerning the conservation and development of fish and wildlife

Table 39 (Con.)

resources, by the Secretary of the Interior; (2) the inclusion in project work plans of such works of improvement for fish and wildlife resources recommended by the Secretary of the Interior as are agreed to by the local organization and the Secretary of Agriculture; (3) cost sharing by the Secretary of Agriculture of lands, easements, or rights-of-way acquired by the local organization for any reservoir or other area operated and managed by such organization as public fish and wildlife or recreational developments, and (4) cost sharing by the Secretary of Agriculture for installation of works of improvement for certain project purposes including fish and wildlife developments.

Fish and Wildlife Act of 1956. Act of August 8, 1956, (70 Stat. 1119 as amended 16 U.S.C. 742a-742k). Establishes a comprehensive national fish and wildlife policy; establishes the present U.S. Fish and Wildlife Service; directs the Secretary of the Interior to provide continuing research, extension, and information services and to take any necessary steps to develop, manage, and conserve fishery and wildlife resources, including the acquisition of refuge lands for all forms of wildlife and the development of existing facilities.

Fish and Wildlife Recreation Act. Act of September 28, 1962, (76 Stat. 653; 16 U.S.C. 460k--460k-4). Establishes public recreation as an authorized use of conservation areas of the Department of the Interior and authorizes acquisition of limited land areas for recreational development adjacent to existing or approved conservation areas.

Water Resources Research Act. Act of July 17, 1964, (78 Stat. 329 as amended 42 U.S.C. 1961--1961c-6). Authorizes Federal financial assistance to States in establishing water resources research and training programs, and authorizes financial assistance to individuals and private and public agencies having competence in water research for research on specific projects.

Land and Water Conservation Fund Act of 1965. Act of September 3, 1964, (78 Stat. 897; 16 U.S.C. 4601-4--4601-11). Creates a Land and Water Conservation Fund from which Congress may appropriate funds for specified purposes, including (1) the acquisition of lands and waters for any national area that may be authorized for the preservation of species of fish and wildlife threatened with extinction, and (2) for limited acreages adjacent to national wildlife refuges, national fish hatcheries, and other national wildlife conservation areas, for recreational purposes. Also authorizes matching grants to the States for the acquisition and development of lands and waters for recreation purposes.

Federal Water Project Recreation Act. Act of July 9, 1965, (79 Stat. 213; 16 U.S.C. 4601-12--4601-21). Provides uniform policies with respect to recreation and fish and wildlife benefits and costs of

Table 39 (Con.)

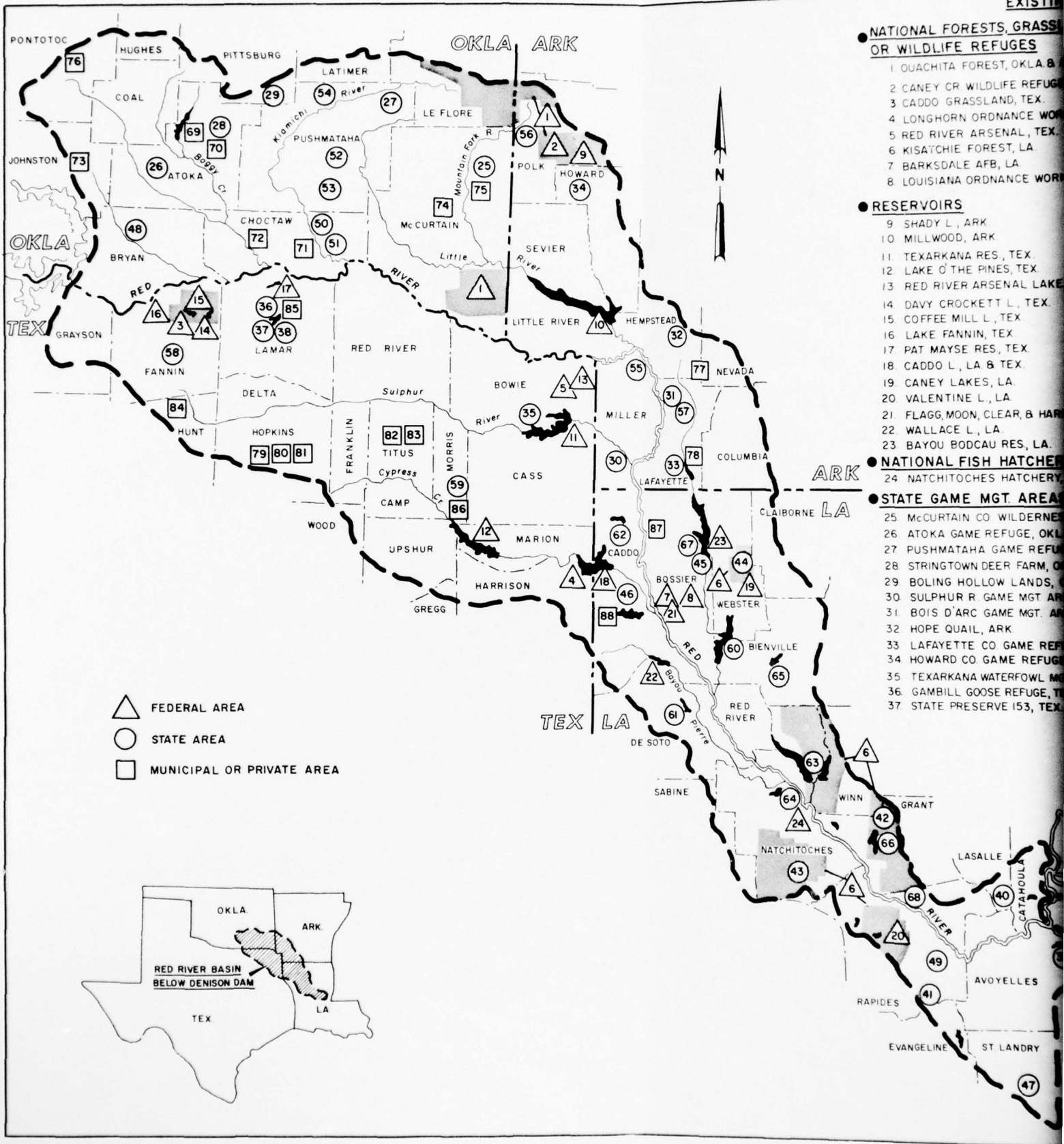
Federal multiple-purpose water-resources projects and administration by non-Federal agencies of project lands and waters for recreation and fish and wildlife enhancement purposes and to operate and maintain facilities for these purposes; authorizes the Secretary of the Interior to provide for outdoor recreation and fish and wildlife facilities at reservoirs under his control; and authorizes the expenditures of project funds to acquire lands for enhancement of migratory waterfowl at Federal water-resources projects to an aggregate of $28,000,000.

Food and Agriculture Act of 1965. Act of November 3, 1965, (79 Stat. 1187, 1206; 7 U.S.C. 1838). Known as the Cropland Adjustment Act, Title VI. Authorizes the Secretary of Agriculture to transfer funds to any other Federal agency or to States or local government agencies for use in acquiring cropland for the development of wildlife or recreation facilities.

Water Resources Planning Act. Act of July 22, 1965, (79 Stat. 244 as amended 42 U.S.C. 1962-1962d-3). Provides for the optimum development of the Nation's natural resources through the coordinated planning of water and related land resources; establishes a Water Resource Council at the Federal level; authorizes the establishment of river basin commissions; and provides for financial assistance to the States in order to increase State participation in comprehensive planning.

Endangered Species Act. Act of October 15, 1966. Provides for the conservation, protection, and propagation of native species of fish and wildlife threatened with extinction and consolidates authorities relating to administration of the National Wildlife Refuge System.

Anadromous Fish Act. Act of October 30, 1965, 79 Stat. 1125; 16 U.S.C. 757 a.f.). Authorizes the Secretary of the Interior to initiate with the States a cooperative program for conservation, development, and enhancement of the Nation's anadromous fish. The Act is unique in that it is the only Federal legislation providing grants and aid to States and other non-Federal interests exclusively for anadromous fish. Related Federal laws include the Federal Power Act (41 Stat. 1063, as amended); the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; the Columbia River Basin Fishery Development Program (52 Stat. 345, as amended); the Federal Aid in Fish Restoration Act (64 Stat. 430, as amended); the Saltonstall-Kennedy Act (68 Stat. 376, as amended); and the Commercial Fisheries Research and Development Act (78 Stat. 197).


EXISTI
NATIONAL FORESTS, GRASS
OR WILDLIFE REFUGES
1 OUACHITA FOREST, OKLA & A
2 CANEY CR WILDLIFE REFUG
3 CADDO GRASSLAND, TEX.
4 LONGHORN ORDNANCE WOR
5 RED RIVER ARSENAL, TEX.
6 KISATCHIE FOREST, LA
7 BARKSDALE AFB, LA
8 LOUISIANA ORDNANCE WOR
RESERVOIRS
9 SHADY L., ARK
10 MILLWOOD, ARK
11 TEXARKANA RES., TEX.
12 LAKE O' THE PINES, TEX.
13 RED RIVER ARSENAL LAKE
14 DAVY CROCKETT L., TEX.
15 COFFEE MILL L., TEX.
16 LAKE FANNIN, TEX.
17 PAT MAYSE RES., TEX.
18 CADDO L., LA & TEX.
19 CANEY LAKES, LA.
20 VALENTINE L., LA.
21 FLAGG, MOON, CLEAR, & HAR
22 WALLACE L., LA.
23 BAYOU BODCAU RES, LA.
NATIONAL FISH HATCHER
24 NATCHITOCHES HATCHERY
STATE GAME MGT. AREA
25 McCURTAIN CO. WILDERNE
26 ATOKA GAME REFUGE, OKL
27 PUSHMATAHA GAME REFU
28 STRINGTOWN DEER FARM, O
29 BOLING HOLLOW LANDS,
30 SULPHUR R. GAME MGT AR
31 BOIS D'ARC GAME MGT. A
32 HOPE QUAIL, ARK.
33 LAFAYETTE CO. GAME REF
34 HOWARD CO. GAME REFUG
35 TEXARKANA WATERFOWL M
36 GAMBILL GOOSE REFUGE, T
37 STATE PRESERVE 153, TEX.
OKLA
ARK
TEX
LA
N
PONTOTOC
HUGHES
PITTSBURG
LATIMER
LE FLORE
COAL
JOHNSTON
ATOKA
PUSHMATAHA
POLK
HOWARD
CHOCTAW
McCURTAIN
SEVIER
BRYAN
RED RIVER
LITTLE RIVER
HEMPSTEAD
GRAYSON
LAMAR
FANNIN
DELTA
BOWIE
NEVADA
HUNT
HOPKINS
TITUS
MILLER
COLUMBIA
CASS
LAFAYETTE
CLAIBORNE
WOOD
CAMP
UPSHUR
MARION
CADDO
BOSSIER
WEBSTER
HARRISON
GREGG
BIENVILLE
DE SOTO
SABINE
WINN
GRANT
NATCHITOCHES
LASALLE
CATAHOULA
AVOYELLES
RAPIDES
EVANGELINE
ST LANDRY
FEDERAL AREA
STATE AREA
MUNICIPAL OR PRIVATE AREA
RED RIVER BASIN
BELOW DENISON DAM

EXISTING FISH AND WILDLIFE FACILITIES

● NATIONAL FORESTS, GRASSLANDS, OR WILDLIFE REFUGES

1. OUACHITA FOREST, OKLA & ARK.
2. CANEY CR. WILDLIFE REFUGE, ARK.
3. CADDO GRASSLAND, TEX.
4. LONGHORN ORDNANCE WORKS, TEX.
5. RED RIVER ARSENAL, TEX.
6. KISATCHIE FOREST, LA.
7. BARKSDALE AFB, LA.
8. LOUISIANA ORDNANCE WORKS, LA.

● RESERVOIRS

9. SHADY L., ARK.
10. MILLWOOD, ARK.
11. TEXARKANA RES., TEX.
12. LAKE O' THE PINES, TEX.
13. RED RIVER ARSENAL LAKES, TEX.
14. DAVY CROCKETT L., TEX.
15. COFFEE MILL L., TEX.
16. LAKE FANNIN, TEX.
17. PAT MAYSE RES., TEX.
18. CADDO L., LA & TEX.
19. CANEY LAKES, LA.
20. VALENTINE L., LA.
21. FLAGG, MOON, CLEAR, & HARMON LAKES, LA.
22. WALLACE L., LA.
23. BAYOU BODCAU RES., LA.

● NATIONAL FISH HATCHERY

24. NATCHITOCHES HATCHERY, LA.

● STATE GAME MGT. AREAS

25. McCURTAIN CO. WILDERNESS AREA, OKLA.
26. ATOKA GAME REFUGE, OKLA.
27. PUSHMATAHA GAME REFUGE, OKLA.
28. STRINGTOWN DEER FARM, OKLA.
29. BOLING HOLLOW LANDS, OKLA.
30. SULPHUR R. GAME MGT. AREA, ARK.
31. BOIS D'ARC GAME MGT. AREA, ARK.
32. HOPE QUAIL, ARK.
33. LAFAYETTE CO. GAME REFUGE, ARK.
34. HOWARD CO. GAME REFUGE, ARK.
35. TEXARKANA WATERFOWL MGT. AREA, TEX.
36. GAMBILL GOOSE REFUGE, TEX.
37. STATE PRESERVE 153, TEX.

● STATE GAME MGT. AREAS - CON'T.

38. STATE GAME PRESERVE 154, TEX.
39. GRASSY L. GAME MGT. AREA, LA.
40. SALINE GAME MGT. AREA, LA.
41. ALEXANDER GAME MGT. AREA, LA.
42. CATAHOULA GAME MGT. AREA, LA.
43. RED DIRT GAME MGT. AREA, LA.
44. CANEY GAME MGT. AREA, LA.
45. BODCAU GAME MGT. AREA, LA.
46. SODA L. GAME MGT. AREA, LA.
47. THISTLETHWAITE GAME MGT. AREA, LA.

● STATE FISH HATCHERIES

48. DURANT HATCHERY, OKLA.
49. BEECHWOOD HATCHERY, LA.

● STATE FISHING LAKES

50. SCHOOLER L., OKLA.
51. L. RAYMOND GARY, OKLA.
52. CLAYTON L., OKLA.
53. L. OZZIE COBB, OKLA.
54. L. NINIH WAIYA, OKLA.
55. FIRST OLD RIVER L., ARK.
56. L. WILHELMINA, ARK.
57. BOIS D'ARC RES., ARK.
58. BONHAM STATE PARK L., TEX.
59. DAINGERFIELD STATE PARK L., TEX.
60. L. BISTINEAU, LA.
61. SMITHPORT L., LA.
62. BLACK L., LA.
63. BLACK-SALINE-CLEAR LAKES, LA.
64. CANE RIVER L., LA.
65. KEPLER CR. L., LA.
66. IATT LAKE, LA.
67. IVAN LAKE, LA.
68. FT. BUHLOW L., LA.

● MUNICIPAL & PRIVATE LAKES

69. ATOKA RESERVOIR, OKLA.
70. ATOKA CITY L., OKLA.
71. HUGO CITY L., OKLA.
72. BOSWELL CITY L., OKLA.
73. WAPANUCHA CITY L., OKLA.
74. BROKEN BOW CITY L., OKLA.
75. HOCHATOWN L., OKLA.
76. ADA CITY L., OKLA.
77. LAKE JUNE, ARK.
78. LAKE ERLING, ARK. (PRIVATE)
79. CENTURY L., TEX.
80. COLEMAN L., TEX.
81. WHITE OAK L., TEX.
82. LAKE TANKERSLY, TEX.
83. OLD CITY L., TEX.
84. WOLFE CITY L., TEX.
85. CROOK L., TEX.
86. LONE STAR L., TEX. (PRIVATE)
87. CYPRESS BAYOU - SITE 2, LA.
88. CROSS LAKE, LA.

RED RIVER BASIN BELOW DENISON DAM
ARKANSAS, LOUISIANA, OKLAHOMA, AND TEXAS

COMPREHENSIVE BASIN STUDY

EXISTING FISH AND WILDLIFE FACILITIES

0 10 20 30 40 50 MILES

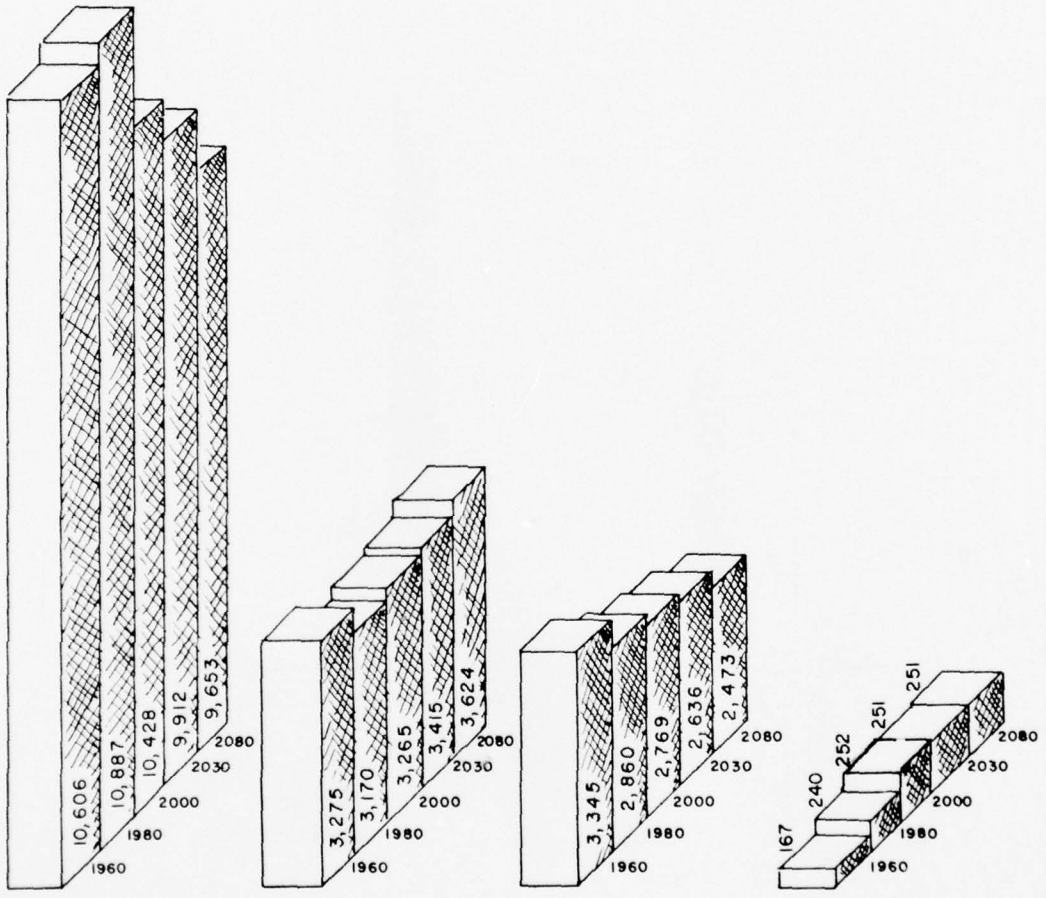
TO ACCOMPANY REPORT DATED JUNE 1968

PREPARED BY BUREAU OF SPORT FISHERIES AND WILDLIFE

PLATE I

WILDLIFE HABITAT ACREAGE (1,000)- 1960-2080

RED RIVER BASIN BELOW DENISON DAM



FOREST LAND

PASTURE–RANGE

CROPLAND

WATER

(Scale magnified two times)

PLATE 2

SPORT FISHERY RESOURCE INVENTORY (1,000 ACRES)

RED RIVER BASIN BELOW DENISON DAM

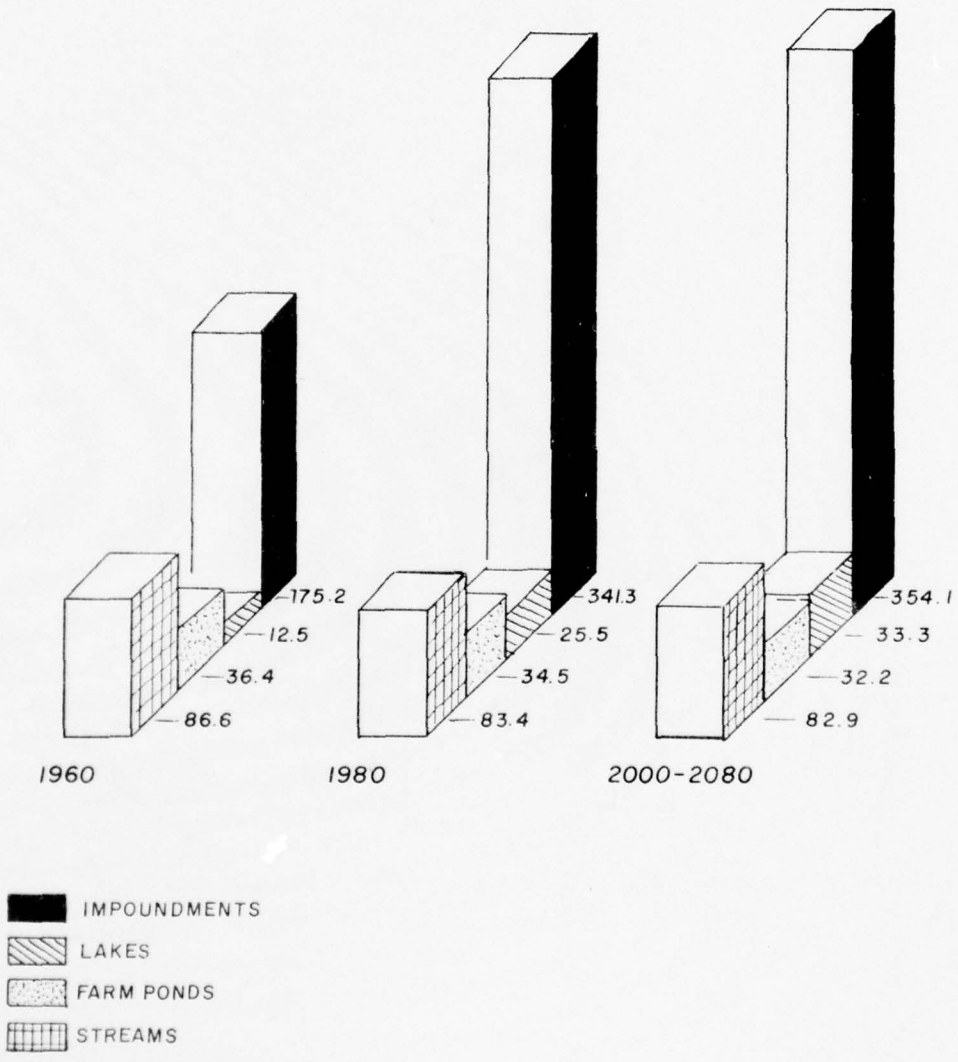


PLATE 3


PONTOTOC
HUGHES
PITTSBURG
LATIMER
LE FLORE
COAL
JOHNSTON
ATOKA
BUSHMATAHA
POLK
HOWARD
CHOCTAW
McCURTAIN
SEVIER
OKLA
BRYAN
RED RIVER
TEX
GRAYSON
FANNIN
LAMAR
RED RIVER
LITTLE RIVER
HEMPSTEAD
NEVADA
DELTA
BOWIE
HUNT
HOPKINS
FRANKLIN
TITUS
MORRIS
CASS
MILLER
LAFAYETTE
ARK
LA
WOOD
UPSHUR
MARION
CADDO
BOSSIER
CLAIBORNE
HARRISON
GREGG
WEBSTER
BIENVILLE
RED RIVER
TEX LA
DE SOTO
WINN
SABINE
NATCHITOCHES
GRANT
LASALLE
CATAHOULA
RAPIDES
AVOYELLES
EVANGELINE
ST LANDRY
N
OKLA
ARK
RED RIVER BASIN
BELOW DENISON DAM
TEX.
LA

AD-A036 753 RED RIVER BASIN COORDINATING COMMITTEE NEW ORLEANS LA F/G 8/6
COMPREHENSIVE BASIN STUDY. RED RIVER BELOW DENISON DAM, ARKANSA--ETC(U)
JUN 68

UNCLASSIFIED NL

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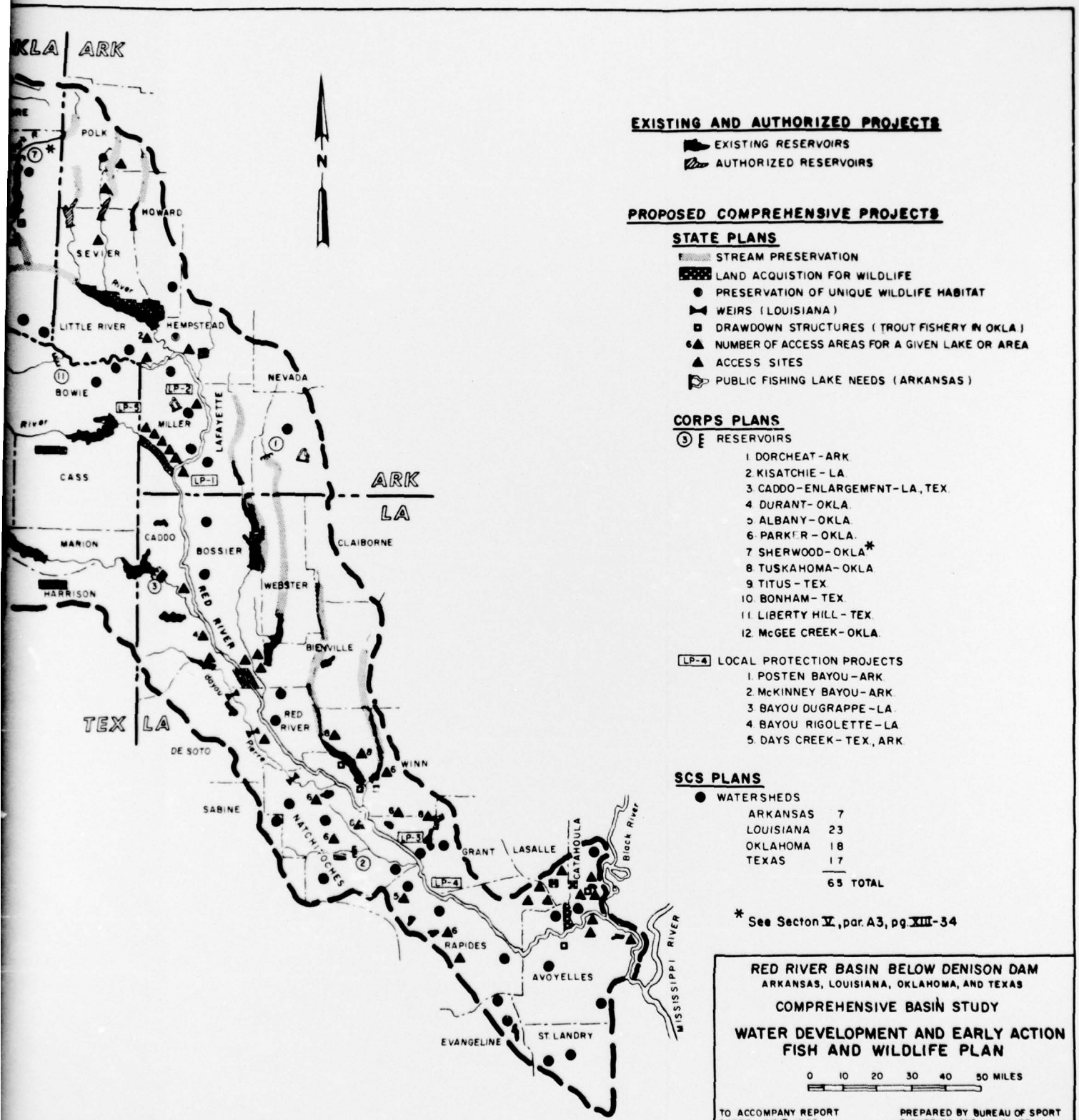

EXISTING AND AUTHORIZED PROJECTS

- EXISTING RESERVOIRS
- AUTHORIZED RESERVOIRS

PROPOSED COMPREHENSIVE PROJECTS

STATE PLANS

- STREAM PRESERVATION
- LAND ACQUISTION FOR WILDLIFE
- PRESERVATION OF UNIQUE WILDLIFE HABITAT
- WEIRS (LOUISIANA)
- DRAWDOWN STRUCTURES (TROUT FISHERY IN OKLA.)
- 6▲ NUMBER OF ACCESS AREAS FOR A GIVEN LAKE OR AREA
- ▲ ACCESS SITES
- PUBLIC FISHING LAKE NEEDS (ARKANSAS)

CORPS PLANS

③ RESERVOIRS

1. DORCHEAT - ARK.
2. KISATCHIE - LA.
3. CADDO - ENLARGEMENT - LA., TEX.
4. DURANT - OKLA.
5. ALBANY - OKLA.
6. PARKER - OKLA.
7. SHERWOOD - OKLA.*
8. TUSKAHOMA - OKLA.
9. TITUS - TEX.
10. BONHAM - TEX.
11. LIBERTY HILL - TEX.
12. McGEE CREEK - OKLA.

LP-4 LOCAL PROTECTION PROJECTS

1. POSTEN BAYOU - ARK.
2. McKINNEY BAYOU - ARK.
3. BAYOU DUGRAPPE - LA.
4. BAYOU RIGOLETTE - LA.
5. DAYS CREEK - TEX., ARK.

SCS PLANS

● WATERSHEDS

ARKANSAS	7
LOUISIANA	23
OKLAHOMA	18
TEXAS	17
	65 TOTAL

* See Secton V, par. A3, pg. XIII-34

RED RIVER BASIN BELOW DENISON DAM
ARKANSAS, LOUISIANA, OKLAHOMA, AND TEXAS

COMPREHENSIVE BASIN STUDY

WATER DEVELOPMENT AND EARLY ACTION FISH AND WILDLIFE PLAN

0 10 20 30 40 50 MILES

TO ACCOMPANY REPORT DATED JUNE 1968

PREPARED BY BUREAU OF SPORT FISHERIES AND WILDLIFE

PLATE 4

APPENDIX XIII

FISH AND WILDLIFE

ATTACHMENT A

COPY OF
RESOLUTION OF OKLAHOMA WILDLIFE
CONSERVATION COMMISSION
DATED MAY 6, 1968

R E S O L U T I O N

WHEREAS, Mountain Fork River upstream from Broken Bow Reservoir is the subject of study for development of a reservoir, and

WHEREAS, the present river is an important fishing stream and was designated a "Smallmouth Bass Stream" that "provides 'quality recreation' which must be preserved (Wildlife Conservation Commission Resolution F-8-67, October 2, 1967)," and

WHEREAS, large reservoirs authorized and under study will inundate 300 of the 500 miles of free-flowing smallmouth bass streams in Oklahoma, and another 100 miles will be reduced in quality when short tributaries are isolated from the main stream by reservoirs, and

WHEREAS, Sherwood Reservoir is under study and is proposed for construction on this stream;

IT IS RESOLVED, THEREFORE, by the Oklahoma Wildlife Conservation Commission that the Federal Government be requested to cease planning the Sherwood Reservoir Project in the interest of additional recreation on this scenic stream, and that the Oklahoma Department of Wildlife Conservation develop access where it is needed by the public, and manage the stream to provide for public recreation during the period this stream remains in its free-flowing state. The Commission joins the State of Arkansas and its State Committee for Stream Preservation in requesting that this stream be preserved in its free-flowing state;

IF, HOWEVER, Sherwood Dam and Reservoir is authorized by the Congress of the United States then this Commission requests the Congress to authorize appropriate features in the interest of fish and wildlife conservation as recommended by the Department of Wildlife Conservation, and delay construction as long as possible,

FURTHER, the Oklahoma Wildlife Conservation Department is authorized to provide up to one-half the cost of a fish hatchery for production of fish for enhancement, parking lot and berm which will be needed by fishermen.

DATED this 6th day of May, 1968.

s/Leslie Vanderwork
CHAIRMAN

s/John F. Hines
SECRETARY

ATTEST

s/George L. Knapp

s/Elmer A. Vieth

s/Harold S. Cooksey

s/Jack C. Parish

s/Fred P. Lewis

s/Paul Roeber

ATTACHMENT A